सत्यमेव जयते

Indian Agricultural
Research Institute, New Delhi

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DICTYOPHORA DUPLICATA

DICTYOPHORA DUPLICATA

FRED J. SEAVER

(WITH FRONTISPIECE)

It has been customary in time past to publish outstanding photo-graphs of fungi in MYCOLOGIA, and the practice should be continued when such are available. We have recently received from Maurice B. Walters what we regard as a rather striking illustration of the above named species, with the following notes:

"On Sept. 18th I found, in beech-hemlock woods near Cleveland, the largest and most perfect specimen of *Dictyophora duplicata* I have ever seen, a trifle over nine inches high, and with net unbroken. I succeeded in getting it home undamaged, and my resulting photo also came thru without a flaw. I have made a life-size enlargement and am sending it to you under separate cover. I know you sometimes make use of photos of unusual specimens for MYCOLOGIA; of course I do not know how unusual this one is, but I have not seen any published photograph of such a flawless specimen as this."

Mr. Walters is to be commended for his good fortune in finding such a magnificent specimen, and getting it home without injury; also for his ability as a photographer. We take great pleasure in reproducing this unusually fine illustration, and would be glad to have similar contributions from other mycologists.

NEW YORK BOTANICAL GARDEN

AN UNDESCRIBED LAGENIDIUM PARA-
SITIC UPON POTAMOGETON

V. M. Cutter, Jr.

(with 21 figures)

Phycomycetous parasites in the root hairs of terrestrial plants have been reported in numerous instances, but the presence of these organisms in the root hairs of aquatic plants has been largely overlooked. This paucity of records may be due to the fact that, until recently, the presence of root hairs on the great majority of aquatic plants had not been realized. Consequently, it is of interest to record the occurrence of a Phycomycete parasite infecting the root hairs of a true aquatic and causing a marked hypertrophy of these structures.

In May 1941, Dr. W. C. Muenscher of this University called the writer's attention to a collection of seedlings of *Potamogeton spirillus* Tuckerman with root hairs showing curious pyriform or spherical swellings. Many of these swollen hairs were hyaline and completely empty, but spore-like bodies which resembled *Pythium* oögonia were present in a few. There was, however, no trace of any mycelium in either the root hairs or the cells of the root. Further search revealed root hairs in which the protoplasmic contents had apparently been incorporated into an amoeboid mass lying in the swollen tip of the hair. These lobulated masses were immediately suggestive of the thalli of the Lagenidiaceae. During the course of the preliminary study, one of these amoeboid thalli produced a number of zoöspores; but it was not possible at the time to ascertain definitely the flagellation of these swarmers. A second collection of more mature seedlings taken from the same locality on July 2, 1941, showed an occasional infected root hair; but in this instance, only the amoeboid thalli were present, and zoöspore discharge was not observed. Obviously the affinities of this organism could only be determined by a careful study of its zoöspores. With this in mind, another collection was made from

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the same station on May 27, 1942. In this third collection the parasite was again present, and a more representative series of stages was obtained. A final collection made July 2, 1942, showed many empty root hairs and the presence of a few vegetative and resting thalli.

HABITAT

The seedlings of *Potamogeton spirillus* Tuckerman were collected at two localities in Oquaga Lake, Broome County, New York, the first in slowly running water near the outlet and the second in a boat slip at the western end of the lake. This lake lies at an elevation of 1571 feet and, judging from the vegetation, shows an acid reaction. At the time of collection the water was in the 40–60° F. range. The plants were growing in 1–3 feet of water, and were all seedlings. Mature plants collected at the outlet showed no infection. In the heaviest infection seen, that of May 30, 1941, approximately 50 per cent of the root hairs showed hypertrophy. In the 1942 material infection was much less severe, only an occasional root hair showing the presence of the fungus. Seedlings of *Sparganium, Eriocaulon, Juncus, Eleocharis* and *Callitriche,* and young plants of *Isoetes* taken from the vicinity of the infected *Potamogeton* showed no trace of infection. A number of other species of *Potamogeton* and *Najas* seedlings from other localities were examined in the hope of finding the same fungus, but no similar infection has been noted. It is possible, of course, that this fungus may be specific on *P. spirillus.*

DEVELOPMENT OF THE ZOÖSPORANGIAL THALLUS

The first evidence of the parasite's presence in the root hair is a gradual disappearance of the protoplasmic contents and an enlargement of the tip of the hair. The thallus appears plasmodial at first; but soon a definite membrane may be distinguished, and at this time the contents of the thallus become granular and oil droplets are formed in the cytoplasm. The bright blue or purple reaction obtained when the thallus membrane is treated with chloriodide of zinc indicates that true cellulose is present in the cell wall. This suggests a close affinity with the Lagenidiaceae, in which

Couch (2) and others have demonstrated the presence of cellulose, and with the higher Phycomycetes. Considered in conjunction with the nature of the zoöspores, this character further proves the impossibility of grouping this fungus with the Chytridiales.

As the thallus matures, it assumes a pale golden color with a greenish gleam. The thalli are at first subspherical or elliptical, becoming much lobed and convoluted in age (FIG. 3). The spherical thalli may reach a diameter of 90 microns, while elongated individuals may attain even greater dimensions. Several root hairs were observed in which more than one thallus had developed (FIG. 2), and as might be expected, these thalli were much smaller. One such thallus only 12 microns in diameter was observed discharging zoöspores. No septa were seen even in mature thalli.

The fungus is usually confined to the terminal portion of the root hair, where it causes a very marked balloon-like swelling. In none of the material examined was there any evidence that the parasite had infected the epidermal or cortical cells of the root, although many zoöspores were observed coming to rest and encysting upon the root epidermis. This may indicate that the zoöspores are unable to penetrate mature cell walls and can gain entrance to the host only through the very delicate or perhaps injured walls of the expanding root hairs. The infected hairs are almost always shorter than the healthy ones; and growth of the hair apparently ceases after infection has occurred. This may be further evidence that infection only takes place when the root hairs are immature. Aside from this local hypertrophy, the infected seedlings appeared normal in every way and exhibited no pathologic symptoms.

ZOÖSPOROGENESIS

Very shortly after the thallus has reached its maximum development a number of cyst-like bodies measuring 6–12 microns may

FIG. 1, young thalli in root hair, × 285; 2, root hair with several young thalli, × 285; 3, mature lobulated thallus, × 285; 4, thallus before zoöspore discharge, showing pseudocysts, × 285; 5, zoöspore discharge, × 285; 6, swimming and encysted zoöspores, × 510; 7, root hair with empty thallus, × 285; 8, empty zoösporangial thallus and several young resting thalli arising from trapped zoöspores, × 285; 9–10, development of oösphere, × 330; 11, elongated resting thallus with developing oöspores, in stalk of root hair, × 330; 12, developing oösphere in lobe of thallus, × 330; 13, mature oögonium and oöspore, × 330. All figures drawn with the aid of a camera lucida.
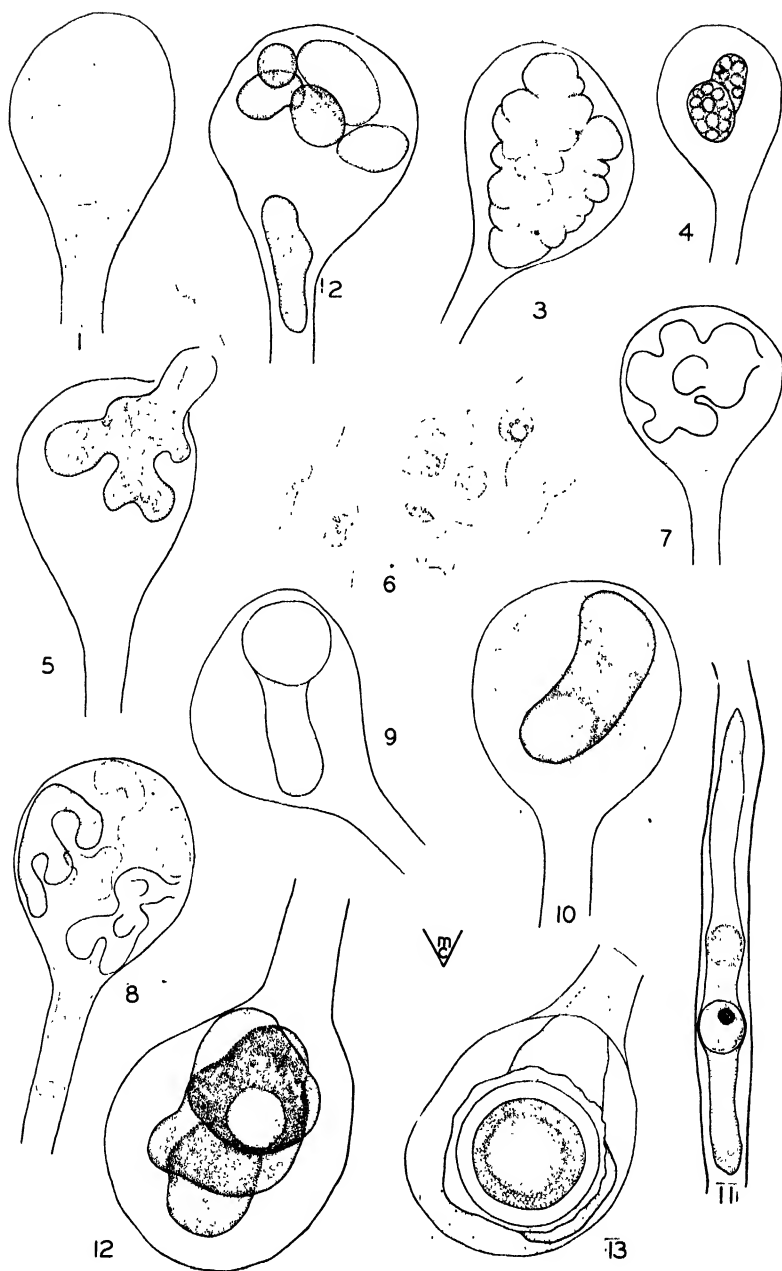
FIGS. 1–13.

be observed within it (FIG. 4). These remain motionless for several hours and then begin to show amoeboid movements. As the cysts change shape the whole thallus, or sometimes only portions of it, commence to rock and jerk about. The nature of these cyst-like bodies is not clear, but observations at a later stage indicate that they probably represent only the zoöspore membranes, since no empty cysts remain in the thallus after the zoöspores have swarmed, as would be the case if the zoöspores went through a preliminary encystment prior to emergence. However, the outlines of the developing zoöspores in these early stages are much more apparent than is usually the case among Water Moulds; and this phenomenon deserves further study, since it may represent a rudimentary type of sporangial encystment, and thus shed light upon the development of true sporangial encystment in such genera as *Thraustotheca* and *Dictyuchus*.

The zoöspores (FIG. 6) are of the familiar biflagellate "grape-seed" type with a number of refringent granules scattered in the cytoplasm. They measure 6–11 × 3–5 microns and swim with a smooth rolling motion quite unlike the erratic darting of chytridi-aceous zoöspores. They are isocont, with prominent flagella measuring up to 25 microns in length. They may remain motile for as long as 12 hours if the oxygen supply of the culture is maintained; but they usually settle down and become amoeboid within several hours, and as their amoeboid motion ceases they round up and encyst. No repeated emergencies of encysted zoöspores were observed, nor were any zoöspores seen to effect entrance to the host, although many encysted zoöspores were observed at rest on healthy root hairs. The question of how infection is accomplished must remain for the present unanswered.

In a number of cases one of the lobes of the thallus was seen to have penetrated the root hair wall just before zoöspore discharge. This portion of the thallus was not particularly differentiated into an exit tube or pore, and the zoöspores were released individually through a simple orifice or break in the projecting lobe (FIG. 5). Infrequently the thallus may produce an elongated exit tube through which the zoöspores are discharged. At the time of release no vesicle or membrane was present into which the zoöspores were discharged. The entire thallus may not be

emptied for several hours. How the thallus accomplishes the rupture of the root hair wall remains in the realm of conjecture. Evidence would favor the theory that enzymatic action dissolves the root hair wall, since the thallus rarely occupies the entire swelling and would, therefore, probably not build up sufficient pressure to cause mechanical rupture of the root hair. On the other hand, the break may well be caused by a tearing of the delicate hair wall as the root elongates, the fungus playing only a passive role in the process. In many instances, zoöspores were discharged from thalli before the root hair was ruptured, and in these cases the trapped spores swam about in the terminal swelling and finally came to rest and encysted *in situ*. This situation presented an unusual opportunity to follow the subsequent course of development of the fungus. The thalli which develop the resting spores apparently arise from these trapped zoöspores.

DEVELOPMENT OF OÖGONIA AND OÖSPORES

After several days in the encysted condition, the zoöspores begin to increase in size and young plasmodial thalli are again in evidence (FIG. 8). By the end of the fourth day after encystment, these daughter thalli are practically as large as the original thallus and differ from it only in the presence of a very large and conspicuous oil globule (FIG. 12). This globule may lie centrally in the thallus or develop in one of the lobes. As differentiation proceeds, the cytoplasm gradually accumulates around the globule soon forming a well demarcated oösphere (FIG. 9). A distinct periplasm is not evident. Soon a conspicuous hyaline to golden yellow wall up to 2.5 microns thick is formed about this oösphere, and the oöspore now lies free within the thallus. The thallus wall therefore represents an oögonium. All the protoplasmic contents of the thallus are not necessarily incorporated within this oöspore, and one or more lobes may remain undifferentiated (FIG. 13). It is problematical whether these lobes function as antheridia, but since no male organ nor any fertilization process was seen it appears likely that the development of the oöspore is apandrous. A particular effort was made to determine whether any fusions occurred between different thalli lying in the root hair

but in the many examples observed no indications of this were noted.

The oöspores range from 10 to 30 microns in diameter, and at maturity have a golden yellow color. In age the irregular contour of the oögonial wall gives them an appearance not unlike the oögonia of some species of *Aphanomyces*. It must be emphasized, however, that the oögonial wall is not decorated with definite protuberances, but only appears so, due to the uneven wrinkling of the external membrane. A few thalli with developing oöspores were noted in the stalks of the root hairs and the terminal swellings were empty (FIG. 11). These presumably arose when zoöspores discharged from a thallus lying in the terminal portion of the hair swam down the stalk and encysted there. Thalli occupying this position were usually considerably elongated, and did not cause any marked hypertrophy. The fact that in all the cases observed the oögonial thalli caused no further hypertrophy, beyond that already induced by the previous presence of zoösporangial thalli, may indicate that the resting spores are only produced upon secondary thalli which develop in previously infected root hairs where the protoplasmic contents have been largely exhausted. Further observation will be necessary to clarify this situation. The germination and subsequent fate of the oöspores has not been observed.

SYSTEMATIC POSITION

This organism possesses certain characteristics intermediate between the Olpidiopsidaceae and Lagenidiaceae of the order Lagenidiales in the classification of Sparrow (6). In the apparently naked, plasmodial-like appearance of the young thallus and the holocarpic nature of the mature thallus, as well as the failure to develop a vesicle into which the zoöspores are discharged, this fungus shows affinities with *Olpidiopsis* Cornu. On the other hand the large size of the zoöspores and the well developed oöspore with eccentric oil globule and smooth wall indicate a close relation-

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FIGS. 14–15, infected root hairs of *Potamogeton*, × 50; 16–17, mature zoösporangial thalli, × 160; 18–19, root hairs with several young resting thalli, × 160; 20, thallus with developing oösphere, × 160; 21, mature oögonium and oöspore, × 160.
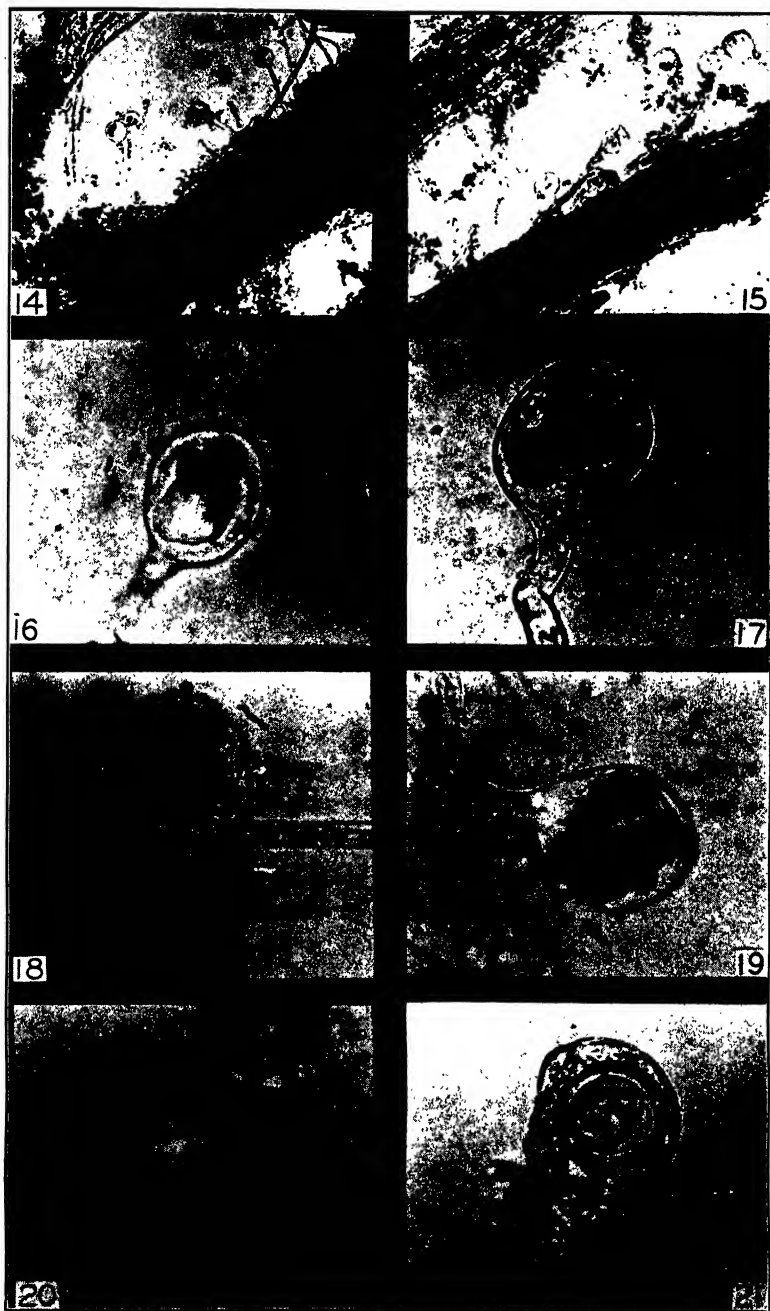
Figs. 14–21.

ship with *Lagenidium* Schenk.   The *Potamogeton* parasite differs
from both these genera in its occurrence on an angiospermous host,
in which it shows a similarity with *Lagena* Vanterpool & Leding-
ham.   The importance of host relationships in determining the
systematic position of parasitic members of the lower Phyco-
mycetes has never been carefully expounded, and for this reason
too much emphasis cannot be laid upon such a character in making
generic distinctions.   The three most important aspects in which
this fungus differs from *Lagena* are : the absence of a definite neck
or attachment collar on the thallus, which remains in contact with
the host wall at the point where the zoöspore gained entrance to
the host; the lack of a discharge vesicle; and the fact that the
Potamogeton parasite is not dioecious.   The first character is un-
doubtedly of great importance, while the latter ·two may be of
only incidental interest from a systematic point of view.   Super-
ficially this fungus resembles *Myzocytium zoopthorum* Sparrow
(4) in the absence of a discharge vesicle, but differs from typical
members of *Myzocytium* Schenk in that the thallus is never seg-
mented or link-like.

Only two characters controvert placing this organism in the genus
Lagenidium.   These are the lack of a sporangial vesicle about the
zoöspores at the time of their discharge, and the apparent lack of
a well defined antheridial branch on the sexual thallus.   The non-
septate character of the thallus might also be raised as an objection
to placing it in this genus.   Although it may be emphatically stated
that in the present material no sporangial vesicle was present and
the zoöspores were delimited within the thallus and discharged
individually, it is equally probable that under different environ-
mental conditions a vesicle may be formed.   The accounts of sev-
eral workers notably Atkinson (1), Scherffel (3), and Sparrow
(5) indicate that in *Lagenidium* a vesicle is not invariably present,
and at best its presence may be only momentary.   In regard to
the absence of an antheridial branch on the sexual thalli two ex-
planations present themselves.   Either this structure is transitory
and collapses immediately after fertilization and has thus been
overlooked, or conjugation may be lateral as in the genus *Myzo-
cytium* with one of the undifferentiated thallus lobes functioning
as the male gametangium.   In addition to these factors the possi-

bility that the fungus is naturally apandrous must be considered. This latter explanation appears more valid since there is little difficulty in clearly observing the thallus as it lies in the hyaline root hair and the presence of an antheridial branch could be easily determined were it present. The non-septate thallus makes the possibility of lateral conjugation unlikely since it is difficult to conceive of a unicellular organism physiologically differentiated into oppositely sexed portions. This lack of septation while unusual in *Lagenidium* has nevertheless been reported in a number of species. It probably represents a primitive condition. The occurrence of apandrous strains is not unusual among the Phycomycetes, and should not stand in the way of assigning an organism to a genus in which true sexuality is the general rule.

From previously described species of *Lagenidium* this fungus may be separated by its large size, parthenogenetically developed oöspores, and occurrence on an angiospermous host as well as by the curious pseudoencystment of the zoöspores just before their release from the thallus. For these reasons it seems best to consider this as a somewhat anomalous species of *Lagenidium*. It is therefore named in honor of Dr. W. C. Muenscher who first collected it, and whose aid in making subsequent collections has been invaluable in this study.

Lagenidium Muenscheri sp. nov.

Thallo intramatricalis, monocentrico, holocarpico, primum nudiusculo, maturitate distincto pariete cellulosam habiente disiuncto, sub-globoso, elliptico, cylindrico, aut lobulo et convoluto, non diviso, 12–20 μ in diam., zoosporis per oro in thalli mure liberatis. Zoosporis hyalinis, minutissime refringentis granulatis, reniformi, lateraliter biflagellatis, isoconti, 6–11 μ × 3–5 μ, maturis emergentibus subitoque enantibus, aequaliter haud emicatim movent, tandem amoeboideis et encystantes, formatis novo thallo directo germinatis. Thallo perdurans apandro, in oogonium transformatur, 40–110 μ in diam. plerumque lobulo. Oosporae sphaericae, parthenogeneticis, flaventes, 18–30 μ in diam. cum eccentrico globulo, murus 1–2.5 μ crassus, germinatio non observata.

Thallus intramatrical, monocentric, holocarpic, appearing naked when young, becoming invested with a cellulose wall at maturity, subspherical, elliptical, elongated or lobed and convoluted, non septate, 12–90 μ in diam., liberating zoöspores through an orifice in the thallus wall. Zoöspores hyaline with numerous minute refringent granules, reniform, laterally biflagellate, isocont, 6–11 μ

$\times$ 3–5 μ, emerging fully formed and swimming away directly (with even non-darting motion) finally becoming amoeboid and encysting, upon germination forming a new thallus directly. Resting thallus apandrous, transformed into an oögonium, 40–110 μ in diam., usually lobed. Oöspores spherical, parthenogenetic, golden 18–30 μ in diam. with eccentric oil globule, oöspore wall smooth, 1–2.5 μ thick. Oöspore germination not observed.

Parasitic upon and causing a hypertrophy of the root hairs of *Potamogeton spirillus* Tuckerman. Type locality: Oquaga Lake, Broome County, New York, May–July 1941–1942. Coll. W. C. Muenscher. Type specimen No. *1001* in herbarium of author at Cornell University.

<div style="text-align:center">

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LITERATURE CITED

1. **Atkinson, G. F.** Some fungus parasites of algae. Bot. Gaz. **48**: 321–338. 1909.
2. **Couch, J. N.** A new saprophytic species of *Lagenidium,* with notes on other species. Mycologia **27**: 376–385. 1935.
3. **Scherffel, A.** Endophytische Phycomyceten-Parasiten der Bacillareaceen und einige neue Monadinen. Ein Beitrage zur Phylogenie der Oomyceten (Schroter). Archiv. Protistenk. **52**: 1–141. 1925.
4. **Sparrow, F. K., Jr.** A contribution to our knowledge of the aquatic Phycomycetes of Great Britain. Jour. Linn. Soc. **50**(334): 417–478. 1936.
5. ——. A new species of *Lagenidium* parasitic on Rotifer eggs. Mycologia **31**: 527–532. 1939.
6. ——. A classification of aquatic Phycomycetes. Mycologia **34**: 113–116. 1942.
7. **Vanterpool, T. C. & Ledingham, G. A.** Studies on "Browning" root rot of Cereals. I. The association of *Lagena radicola* n. gen.; n. sp., with root injury of wheat. Canad. Jour. Res. **2**: 171–194. 1930.

VARIATIONS IN SPORULATION OF DIFFERENT ISOLATES OF COLLETOTRICHUM DESTRUCTIVUM [1]

S. J. P. Chilton [2]

(WITH 2 FIGURES)

Single spore cultures of *Colletotrichum destructivum* O'Gara were found to lose their ability to produce conidia in any quantity when kept in culture. As this seems to be a common phenomenon with several species of *Colletotrichum* and the closely related genus *Gloeosporium,* a study was made of *C. destructivum* to determine, if possible, the nature of this loss of sporulation. A brief summary has been published previously of the results given in 'this paper.[3]

MATERIALS AND METHODS

Fourteen single spore cultures from four hosts were used in the studies (Table 1). All single spore cultures were made with a glass needle and micromanipulator. Unless stated, cultures were compared in triplicate or quadruplicate plates of potato dextrose agar.

Special techniques are given in the experiments in which they were used.

EXPERIMENTAL RESULTS

Description of the original cultures. The 14 cultures used in the studies differed somewhat in cultural characters. Most of

them were nearly black due to the occurrence of small masses of black mycelium scattered in and on the agar. Conidia were plentiful. One culture was lighter in color and produced a pink mass of spores over the center of the colony. The surrounding lighter area was sprinkled with small black masses of mycelium.

Loss of sporulation. When cultures were kept for approximately six weeks or more in tubes of agar, a patch of white, fluffy mycelium would usually appear and spread gradually over the surface of the original growth. If transfers were made to fresh

TABLE 1

SOURCE OF CULTURES OF *Colletotrichum destructivum*

Culture number	Date isolated	Host	Locality
5-1	7/15/38	*Trifolium repens*	State College, Pa.
6-1	7/15/38	*Trifolium repens*	State College, Pa.
14-1	7/18/38	*Trifolium repens*	State College, Pa.
18-1	7/18/38	*Trifolium repens*	State College, Pa.
24-1	7/18/38	*Trifolium pratense*	State College, Pa.
32-1	7/21/38	*Trifolium pratense*	State College, Pa.
150-1	7/29/38	*Trifolium hybridum*	State College, Pa.
224-1	8/13/38	*Trifolium repens*	State College, Pa.
225-1	8/13/38	*Trifolium repens* var. *Ladino*	State College, Pa.
227-2	8/13/38	*Trifolium repens* var. *Ladino*	State College, Pa.
260-1	8/16/38	*Trifolium repens* var. *Ladino*	West Newton, Pa.
329-1	8/21/38	*Trifolium repens*	West Newton, Pa.
332-1	8/21/38	*Trifolium repens*	West Newton, Pa.
338-1	8/21/38	*Trifolium hybridum*	West Newton, Pa.

tubes of agar, the resulting growth seemed to be: (*a*) a mixture of the original type and the white, fluffy mycelium; (*b*) only the second type; or (*c*) a mixture of several types. If transfers were made to plates of agar, the resultant growth would often appear to have sectored (FIG. 1, bottom).

Single spore cultures were made from the tubes in which the fluffy mycelial patches occurred and also from the sectors appearing in petri plates. These cultures when compared differed in many characters. Some produced a few spores and were characterized by a white, fluffy mycelium. Others produced many more conidia than the original type from which they arose, the surface being covered by a pink mass of conidia. Table 2 gives the number of variant types obtained from the 14 cultures. It may be seen that as many as 15 distinct types were secured from
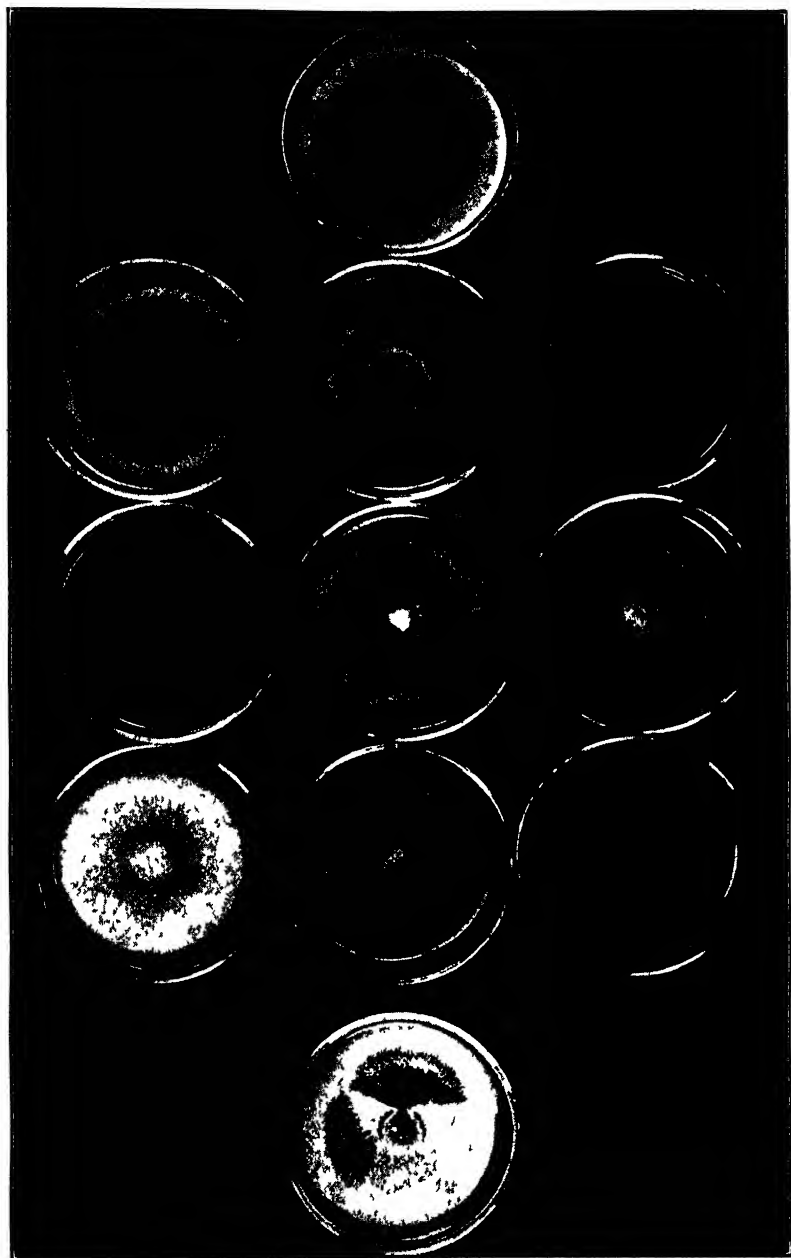
FIG. 1. Top, original culture of *Colletotrichum destructivum;* middle, nine variant types from original culture; bottom, culture showing sectors.

tion was 7.2×10^{30}, after eight, 6.58×10^{67}, and after 10 single spore generations it was 1.8×10^{83}.

Effect of sterile host tissue on poorly sporulating variants. It has been reported that cultures which were losing their ability to sporulate could be rejuvenated by transferring to sterilized host tissue and maintaining them on this medium for several transfers. To test this, petioles and leaflets of *Trifolium repens* were sterilized for 20 minutes at 15 pounds pressure. Tubes were inoculated with each of five poorly sporulating variants and other tubes with the original cultures from which they arose. Periodic transfers were made every 2 to 4 weeks to new host material and at the same time to agar plates to determine if any change occurred. At the end of five successive transfers no difference was found in the 10 cultures used.

In another experiment, cultures which were losing their ability to sporulate were transferred to sterilized host tissue and single spore isolations made. The original sporulating type was obtained.

Effect of the living host on poorly sporulating variants. Repeated passage through the living host has been reported to cause cultures to regain their ability to sporulate. An experiment was made to determine if this occurred with *Colletotrichum destructivum.* Cultures were grown on sterile red clover seedlings in flasks obtained in the following manner: Seed was used which had been tested for the presence of *C. destructivum* by surface sterilizing in 95 per cent alcohol for one minute, a 1–1,000 aqueous solution of mercuric chloride for seven minutes, and a saturated solution of calcium hypochlorite until plated on potato dextrose agar. As none of the 3,000 seed tested in this manner produced the fungus, macroscopically sound seed were selected, surface sterilized as above, and placed in 250 cc. Erlenmeyer flasks containing 50 cc. of potato dextrose agar. After the seed germinated and produced seedlings about three inches in height, all contaminated flasks were discarded. Three single spore cultures of the poorly sporulating type were inoculated on the seedlings. When infection occurred they were transferred to new flasks of seedlings, and, in turn, to other seedlings. On re-isolation to plates the cultures were the same poorly sporulating types.

The occurrence of variants on the living host. In another experiment single spore isolates from two of the original type cultures were made on small pellets of agar 5 mm. in diameter. As soon as the spore produced sufficient mycelium to cover the pellet, half was taken and put in a tube of agar to make sure of the cultural type and the other half was placed on sterile red clover seedlings in a flask. When infection occurred single spores were isolated from those produced on the infected tissue. In all, 986 cultures were isolated and compared in test tubes. One culture, 14–1, produced two variants among 414 isolates. One of these variants was the poorly sporulating white mycelial type and the other differed in other cultural characters.

DISCUSSION

The results obtained indicate that the cause of the loss of sporulation in *Colletotrichum destructivum* in cultures is the occurrence of poorly sporulating variants that replace the original type. These variants were not due to a heterocaryotic condition of the mycelium, and all attempts to rejuvenate them were fruitless. The evidence indicates they are genetic entities differing from the cultures from which they arose. It seems, therefore, that they arise as mutants. The possibility exists that the nuclei in the mycelium are heterozygous diploids which could fuse and segregate in the mycelium, giving rise to variant types.

SUMMARY

1. Studies were made of 14 cultures of *Colletotrichum destructivum* with respect to the loss of sporulation.

2. Variant types were isolated from sectors and patches in old cultures which differed from the original in various cultural characters. Some produced very few spores while others produced many more spores than the original cultures from which they came.

3. The original cultures retained their ability to sporulate through 10 successive single spore generations. Transfers to sterile host tissue and to the living host did not cause poorly sporulating cultures to regain their ability to sporulate heavily.

4. Two variants were obtained from lesions on red clover seedlings produced under sterile conditions.

5. Conidia were predominantly uni-nucleate, a few being found which were bi-nucleate.

6. It is concluded that the loss of sporulation in cultures was due to the occurrence of poorly sporulating types genetically different from the original type which they replaced.

STUDIES IN THE GASTEROMYCETES VII

THE GENUS SCHIZOSTOMA

W. H. Long and David J. Stouffer

(WITH 8 FIGURES)

This paper discusses the taxonomic position of *Schizostoma,* gives an emended description of genus and species and records new data on their distribution.

The genus *Schizostoma* was proposed by Ehrenberg in manuscript for a plant collected in Equatorial Africa and named by him *Schizostoma laceratum.* This genus was not recognized at first and the plant was published by Fries (**1829**) as *Tylostoma laceratum* (Ehrenb.); then Leveille (**1846**) restored the Ehrenberg genus and listed the plant as *Schizostoma lacerum,* but he also included in this genus all species of *Tylostoma* with irregular mouths. Lloyd (**1904**) in his discussion of *Schizostoma* was the first to clearly set forth the true position of this genus and to give an adequate description of its characters. In most of the literature prior to Lloyd's publication it was classed as a *Tylostoma.*

The sub-family, Tylostomoideae, consists of three closely related genera, *Tylostoma, Queletia* and *Schizostoma.* All have sporophores with a specialized fibrous, hollow stem which in the unexpanded stage is a short plug included in the base of the spore sac. The stem emerges from the sporocarp on elongation but remains attached to its base in a socket. This socketed stem is a constant character of all three genera; in some species the apex of the stem is very loosely attached and is easily separated from the spore sac as in *Queletia* and certain species of *Tylostoma,* while in *Schizostoma* the stem is firmly attached in the socket to the endoperidium. The main difference between the three genera is their method of dehiscence.

Key to the Sub-family Tylostomoideae

Sporocarp with a definite apical stoma .... *Tylostoma.*
Sporocarp dehiscing irregularly from the top as in *Calvatia* ...... *Queletia.*
Sporocarp dehiscing by irregular stellate rays along
  definite sutures .... *Schizostoma.*

Sultan Ahmad (1941) in a recent article on the Gasteromycetes of the Panjab Plains, transferred *Schizostoma* to the genus *Queletia.* He claims that the dehiscence and glebal characters are the same and that the two genera differ only in the smaller size of the sporophore and the non-scaly striate stipe of *Schizostoma,* hence should be combined under one genus.

We have carefully examined authentic specimens of *Queletia* from Trexlertown, Penna., U. S. A. (FIG. 7) and from Seuz Sevres, France (FIG. 8) and find that the *dehiscence* of *Queletia* is a crumbling of the top portion of the peridium exactly as in the genus *Calvatia,* with the fragments falling away in succession from the top of the spore sac downward, in fact, *Queletia* is a *Calvatia* with a stalk as far as its dehiscence is concerned. Now in *Schizostoma* we have an entirely different structure and method of dehiscence, the peridium ruptures along definite sutures (FIG. 1) thus forming valves which expand into star-like rays (FIG. 1, 2, 3), these remain intact on the old plants long after the gleba has disappeared (FIG. 4–6). A comparison of figures 7 and 8 of *Queletia* with figures 1–6 of *Schizostoma* gives a clear idea of the existing differences in manner of dehiscence between the two genera. The capillitia and spores are also different as a study of the gleba of each genera shows. In view of the above data it is evident that the two genera are so different that they cannot be combined under one genus as proposed by Ahmad.

Schizostoma Ehrenb. in Lév. Ann. Sci. Nat. III. **5**: 165. 1846.

Sporophore hypogeous in early stages, erumpent and stipitate at maturity; *peridium* of two layers, an exoperidium and an endoperidium; *exoperidium* a sandy coat; *endoperidium* membranous; *dehiscence* by definite sutures in the endoperidium, which rupture into irregular stellate rays; *sterile base* none; *stipe* central, hollow; *gleba* consisting of capillitium and spores; *capillitium* deeply colored, aseptate; *spores* continuous, smooth.

Habitat: growing in arid or semi-arid regions.

Type species: *Schizostoma laceratum* Ehrenberg.

Distribution: Africa; Asia; North America.

Schizostoma laceratum Ehrenb. Ann. Sci. Nat. III. **5**: 165–166. 1846.

1829—*Tylostoma laceratum* (Ehrenb.) Fries, Syst. Myc. **3**: 44.

1846—*Schizostoma lacerum* Lév. Ann. Sci. Nat. III. **5**: 165–166.

1892—*Tylostoma Schweinfurthii* Bres. in P. Henn. Bot. Jahrb. **14**: 359.

1939—*Tylostoma laceratum* var. *nigrum* S. Ahmad, Jour. Ind. Bot. Soc. **18**: 56–57.

1941—*Queletia laceratum* (Ehrenb.) S. Ahmad, Jour. Ind. Bot. Soc. **20**: 135–136.

Sporophore 1½–10 cm. tall, originating 1–8 cm. below the surface of the soil. *Sporocarp* globose to depressed-globose, 1–3 cm. across by 5–20 mm. high, showing a small knob-like, very short bulge in center of glebal cavity where the stem has pushed up bottom of the spore sac. *Exoperidium*, a sandy coat completely deciduous at maturity. *Endoperidium* smooth, membranous, outer surface wood brown (Ridgeway), showing radiating cartridge buff, definite sutures or lines of cleavage (fig. 1); *Dehiscing* by irregular stellate rays (fig. 1–6) along the sutures; rays or *valves* tough, usually remaining intact long after the gleba has disappeared (fig. 4–6) then 1–5 cm. across from tip to tip of the expanded rays which have inner surface cartridge buff after losing the gleba. *Collar* entire, very short, sharp-edged and distant from stem. *Stipe* inserted in a shallow socket in base of sporocarp, very firmly attached, 1–8 cm. tall by 3–9 mm. thick, usually equal but often tapering toward base; terete or sometimes flattened and twisted, striate to sulcate, smooth or rarely with loose thin scales, white without and within, cortex often turning brown on weathering, firm, base usually with a volva-like structure and with a strong root or radicating rhizomorph (fig. 3). *Gleba* chestnut color, usually very coherent, soon dissipated under weathering (fig. 2, 4, 6); *capillitium* long, tortuose, much interwoven, chestnut brown, aseptate, 7–10 microns in diameter, sparingly branched, branches short, often tapering toward ends and thinner than main branches. *Spores* subglobose to broadly oval, 4.5–5.6 microns; *epispore* chestnut color, smooth.

Habitat: Solitary or gregarious in unshaded areas in sandy or gravelly soil.
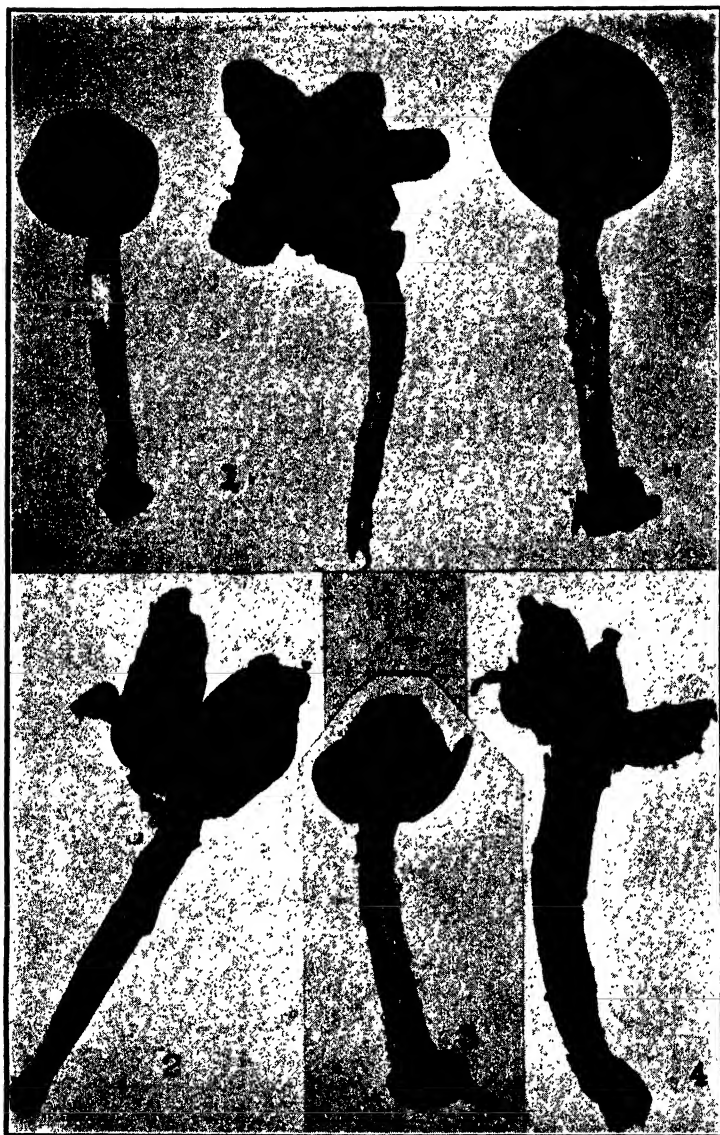
Figs. 1–4, *Schizostoma laceratum,* × 1.

Type locality: Equatorial Africa, Nubia.

Africa:

Equatorial Africa.   Nubia, *several specimens* in Berlin Mus.

Type of *Schizostoma laceratum,* also in Mus. de Paris:

Schweinfurth, G., several specimens in Berlin Mus. under name of *Tylostoma Schweinfurthii: Schweinfurth, G. comm P. Hennings, 1 specimen* in Lloyd Myc. Coll. no. *25531* under name *Schizostoma laceratum.*   Obock, 1892(?) *1 specimen* in Patouillard Herbarium at Farlow Herb. under name *Tylostoma Schweinfurthii.*   Oasis of Sahara, Adrar, Mission Gautier, July 6, 1909. *6 specimens* in Patouillard herbarium at Farlow Herb. under name *Schizostoma laceratum.*

Asia:

India.   Panjab Plains, Sargodha District, Sangla Hill, Jhang, Rohtak, *Sultan Ahmad, Many specimens* in Herb. Ahmad and in Herb. Crypt. Ind. Orient. of the Imperial Agric. Res. Institute, New Delhi, under name of *Tylostoma laceratum, Tylostoma laceratum* var. *nigrum,* and *Queletia laceratum; 9 plants* in herbarium of the University of North Carolina, *Sultan Ahmad* (no. 5), under name *Schizostoma laceratum.*

North America:

Arizona.   Pima County, 8 miles from Tucson road to Sabino Canyon, elevation 2400 feet, *W. H. Long and Victor O. Sandberg,* Nov. 11, 1936—*1 plant* no. *7723: W. H. Long,* June 4, 1938—*20 plants* no. *8242;* Nov. 10, 1938—*17 plants* no. *8241;* Sept. 28–29, 1939—*278 plants* no. *8395: W. H. Long and David J. Stouffer,* Sept. 10, 1941—*2 plants* no. *9626.*   Totalling 318 plants from Arizona.

New Mexico.   Bernalillo County, 10 miles south of Albuquerque, elevation 4950, *W. H. Long,* August 20, 1941—*1 plant* no. *9477: W. H. Long and David J. Stouffer,* Dec. 6, 1941—*1 plant* no. *9920.*   Dona Ana County, Jornado Experimental Range, elevation 4150 feet, *W. H. Long and David J. Stouffer,* Sept. 7, 1941—*7 plants* no. *9588;* Sept. 8, 1941—*36 plants* no. *9603, 30 plants* no. *9609* and *21 plants no. 9612: Kenneth A. Valentine,* Sept. 24, 1941—*2 plants* no. *9836.* Luna County, 10 miles west of Deming on Highway 70, elevation 4300 feet, *W. H. Long and David J. Stouffer,* Sept. 13, 1941—*1 plant* no. *9655:* making a total of 99 plants from New Mex.
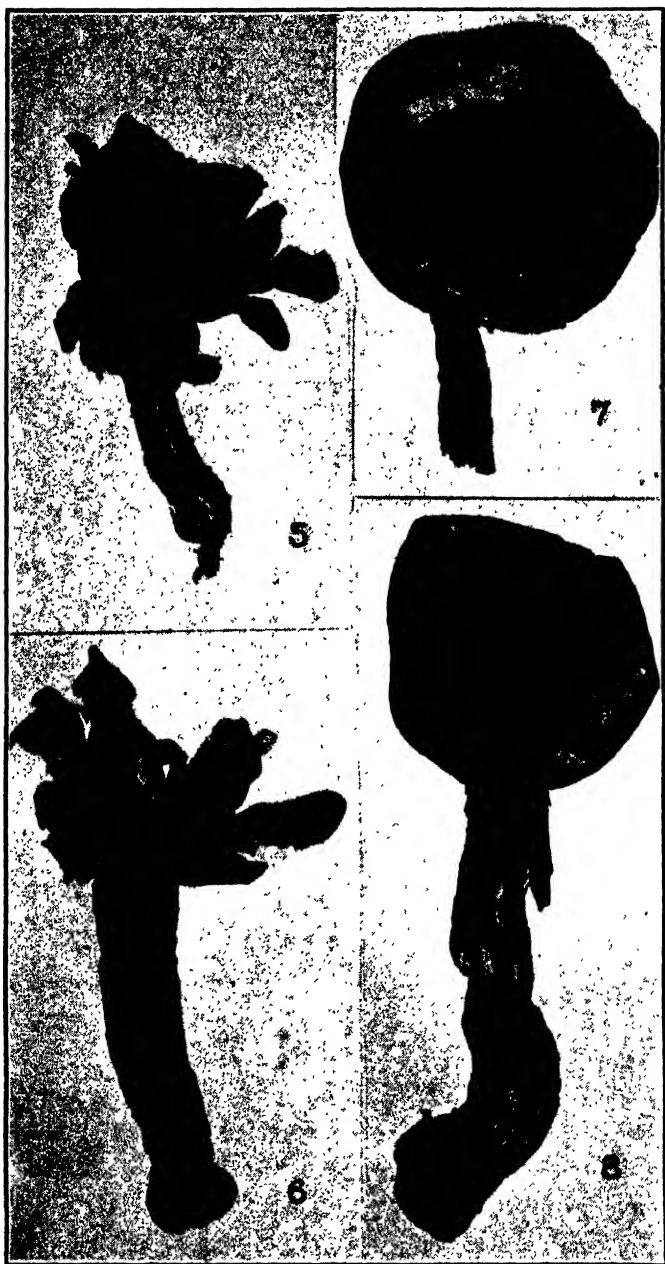
FIGS. 5–6, *Schizostoma laceratum*, × 1; 7–8, *Queletia mirabilis*, × 1.

Mexico. Lower California, San Nicolas Bay, *Ivan M. Johnston* (no. *117*), May 17, 1921—*1 specimen* in Lloyd Myc. Coll. no. *25543*, under name *Schizostoma laceratum*.

ILLUSTRATIONS: Bot. Jahrb. **14**: *pl. 6, f. 5.* Lloyd Myc. Writ. **1**: *pl. 20, f. 1–9;* **7**: *pl. 227, f. 2324.* Jour. Ind. Bot. Soc. **18**: *pl. 2, f. 5; pl. 3, f. 1, 9.*

Schizostoma Mundkuri (S. Ahmad) comb. nov.

1941. *Queletia Mundkuri* S. Ahmad. Jour. Ind. Bot. Soc. **20**: 136–137.

Sporophore 6–18 cm. tall, originating 4–14 cm. below the surface of soil. *Sporocarp* irregular globose to depressed-globose, sometimes broader at apex, 3–5 cm. broad by 1–3 cm. high, showing a knob-like bulge in base of glebal cavity just above the stem apex. *Exoperidium*, a sandy coat completely deciduous on emergence from soil. *Endoperidium* smooth, membranous, light ochraceous buff becoming wood brown in age (Ridgway); *dehiscence* by large very irregular stellate rays along definite sutures which do not extend to bottom of spore sac; *rays* persisting long after dehiscence, rather lax and flexible under weathering. *Collar* prominent formed by the prolongation of the endoperidium, closely appressed to stem, usually very long, often extending down around top of stipe for 15 mm. and terminating in a fimbriate margin. *Stipe* inserted in a shallow socket, firmly attached to base of spore sac, 4–15 cm. tall by 1–2 cm. thick, hollow, white when fresh but part above surface of ground becoming light ochraceous buff to wood brown with age, tapering to base or sub-equal, often enlarged at apex, terete, striate to sulcate, scaly; scales thin, fibrillose, ribbon-like, fragile, resembling somewhat the scales of a *Battarrea;* *volva* present in specimens at hand, double, outer layer membranous with white context, covered externally with closely adhering grains of sand, inner layer of volva a mass of ribbon-like pieces with lacerate tips which apparently are fragments of the stem scales, these segments are short next to outer volva but increase in length inwardly until those next to stem may be 3 cm. long, similar in this respect to the volvas of *Battarrea digueti;* base of stem usually rooting (according to Ahmad). *Gleba* chestnut color, upper ⅔ soon dissipated under weathering, but basal portion very persistent in the lower shallow cup-like bottom of the spore sac; *capillitium* tortuose, usually long and intertwined with shorter threads, coloured to pale yellow, aseptate, very variable in thickness, 3–12.6 microns in diameter, ends closed and rounded,

sparingly branched, branches short, walls thin easily collapsing. *Spores* broadly oval to subglobose, 4.6 to 5.6 microns; *episporc* smooth, chestnut color.

HABITAT: Solitary in sandy soil. Very common in sandy wastes.

TYPE LOCALITY: India, Jhang.

DISTRIBUTION:

Asia:

India. Panjab Plains, Sangla Hill; Jhang. Rohtak; *Sultan Ahmad,* August 1939; *many specimens* in Herb. Ahmad at Rohtak and in Herb. Crypt. Ind. Orient. of Imp. Agric. Res. Inst. New Delhi. Type of *Queletia mundkuri* S. Ahmad: Rohtak, Panjab, *S. Ahmad* May 15, 1940, *4 specimens* (Ahmad no. *298*) in Long Herb. (*10262*) under name of *Queletia mundkuri.*

The above description of *Schizostoma Mundkuri* was made from material kindly sent us by Prof. Ahmad and agrees in the main with his original description of this species, but includes several important characters not mentioned by him. All of the plants in our collection from Ahmad show a definite volva, while one specimen has a large rooting rhizomorph and another ·has several short root-stubs on base of its volva.

Some might call this species a giant form of *Schizostoma laceratum* but we believe it merits specific rank hence it is retained as a distinct species.

American plants.

The specimens examined from the United States and Mexico all belong to the same species, *Schizostoma laceratum.*

This species is erratic in its appearance, some years being very abundant over certain areas while rare at other times, as evidenced by the collections (FIG. 2, 4, 5, 6) from near Sabino Canyon in Arizona where only 1 plant was found in 1936, 57 in 1938, 278 in 1939 and only 2 plants in 1941, yet all the collections were made on the same area (about 10 acres in size) for each of these years. This area is in a Mesquite-Catclaw flat (*Prosopis-Acacia*) with a heavy clay-sandy soil intermixed with gravel and having a

limestone subsoil. The plants on the area usually were growing around the margins of old abandoned rodent mounds.

On the Jornado Experimental Range in New Mexico, *Schizostoma laceratum,* grew in deep sand having a clay subsoil, on naked areas between the Mesquite-sandhill dunes. Many of these plants when collected September 7–8, 1941 were just emerging from the ground (FIG. 1, 3), in some instances their presence was only indicated by a slight elevation of the sand over the emerging plants; even when fully elongated many of them showed only the sporocarp above the soil, while in some cases not even all of the sporocarp became exposed.

The material collected in Mexico consisted of only 1 plant and was typical of *Schizostoma laceratum.*

Asiatic specimens.

This genus is represented in Asia by 2 species—*Schizostoma laceratum* and *S. mundkuri.* We have seen and studied collections of both of these species from India.

The material sent by Ahmad to the University of North Carolina was probably the basis of his description of *Tylostoma laceratum* in his paper (1939) on the Gasteromyceteae of the Punjab Plains. The plants in this collection varied in size from 2 to 6 cm. tall with sporocarps from 1 to 3 cm. broad; only one plant had any gleba remaining in the spore sac, this easy loss of the gleba is characteristic of this species. These Indian specimens corresponded in every detail to our American plants of *Schizostoma laceratum.*

Ahmad's variety—*Tylostoma laceratum* var. *nigrum*—was not in the collections from India sent to the University of North Carolina by Ahmad. According to the description, this variety differs from the ordinary species only in its small size and the darker color of the gleba. We do not believe such minor and variable characters are sufficient to warrant a variety hence it is listed as a synonym of *Schizostoma laceratum.* Recently we received direct from Prof. Ahmad some fine specimens of his new species—*Queletia Mundkuri.* The results of our study of this material have been incorporated in this paper.

The African collections.

We have examined 2 collections of *Schizostoma laceratum* from Africa. One lot of 6 plants came from an oasis in the Sahara Desert and the other consisting of one plant from Obock.

The Obock plant was 5 cm. tall with a subglobose sporocarp 3 cm. across showing the characteristic knob-like projection in its glebal cavity, exoperidium gone, endoperidium smooth, membranous, wood brown with radiating sutures which have opened into irregular stellate rays 3 cm. long, collar entire, sharp-edged; stipe firmly attached to spore sac, 3 cm. tall, tapering to base, striate, terete with a brownish cortex; gleba walnut brown to chestnut brown. The six plants of the Sahara Desert Collection from Adrar ranged in size from 5 to 6 cm. tall with stems 4–6 mm. thick, usually equal, terete, some smooth, some striate with a whitish to brownish cortex.

Schizostoma laceratum from the three continents, Africa, America and Asia has characters so similar that all plainly belong to one species, only a few minor differences, mainly in size of individual plants are evident in any of these widely separated collections, otherwise their characters are practically identical.

GENERAL REMARKS

The habitat requirements of *Schizostoma* vary greatly as to soil and temperature. In Africa, the original *S. laceratum* came from the vast hot gravel lands of Nubia, while *Tylostoma Schwein-furthii,* a synonym, was found in a similar area in Africa. In Asia according to Ahmad (**1939**) the plants were collected in the hot sandy wastes of the Punjab Plains of India. The American plants grew in a variety of soils: the Arizona specimens were in a sand-clay-gravel soil with a limestone subsoil. The New Mexico plants grew in 2 types of soil, a sandy soil with a clay subsoil in Mesquite-sandhill areas, and on sand-gravel ridges in the foot hills of the Manzano Mountains. The temperatures range from very hot in the sub-tropical zone to much colder in the temperate region where the winters may have temperatures 4–6 degrees below zero Fahr. and snows 2–3 feet deep.

The genus, *Schizostoma,* is unique in its well marked cleavage sutures of the endoperidium before dehiscence, not even in the genus *Geaster* are such sutures evident externally.   Ahmad (**1939**) was the first to report the presence of these sutures.   He wrote as follows, "The writer finds that the peridium ruptures along definite lines which are marked in the unopened specimens by a lighter color, and thus forming definite valves which remain intact even when the gleba is dispersed.   In some specimens the endoperidium opens along the lines mentioned above even when the top portion has not broken at all."

The stipes in the various collections from the three continents show a white stem cortex when emerging from the soil, but may change to various shades of brown with age and weathering.   The interior context of the stems is white in all plants and remains so even in age and under severe weathering.

This genus is probably more widely distributed in the hot, semi-arid regions of the world than the above records show.

Prior to this paper only one specimen of *Schizostoma* was reported from America, a solitary plant found in Mexico and described and illustrated by Lloyd (**1922**).

ALBUQUERQUE, NEW MEXICO
AND
CORONA, NEW MEXICO

BIBLIOGRAPHY

Ahmad, Sultan. 1939. Higher fungi of the Punjab Plains, I. The *Gasteromyceteae.* Jour. Ind. Bot. Soc. **18**: 56–57.
        1941. Higher fungi of the Panjab Plains, III. The *Gasteromycetes.* Jour. Ind. Bot. Soc. **20**: 135–137.

Bresadola, G. 1892. In P. Hennings, Fungi Africani. Bot. Jahrb. **14:** 359.

De-Toni, J. B. 1888. Syll. Fung. **7:** 63.

Ehrenberg, C. G. 1846. In Leveille, Ann. Sci. Nat. III. **5:** 165.

Fischer, Ed. 1899. Plectobasidiineae (Sclerodermineae), E. & P. Nat. Pfl. **1:** 1**, 343,

——. 1933. Gasteromyceteae, E. & P. Nat. Pfl. **7A:** 47.

Fries, E. 1829. Syst. Myc. **3:** 44.

Leveille, J. H. 1846. Description des champignons de l'herbier du Museum de Paris. Ann. Sci. Nat. III. **5:** 165.

——. 1849. Orb. Dict. **7:** 505; **8:** 88.

Lloyd, C. G. 1904. Myc. Writ. **1:** 192–193.

——. 1906. Myc. Writ. **2:** The Tylostomeae, 4.

——. 1923. Myc. Writ. **7:** 1173.

Pfeiffer, L. 1874. Nomenclator Botanicum, **2:** 1083.

Saccardo, P. A. 1895. Syll. Fung. **11:** 161.

MOISTURE–RELATION AS A DETERMINANT FACTOR IN THE TRANSFORMATION OF THE BASIDIA OF CERTAIN POLYPORACEAE

S. R. Bose

(WITH 8 FIGURES)

In (**1935**) I showed that in *Ganoderma lucidum* and some other Polyporaceae (*P. ochroleucus, P. calcuttensis* and *Trametes lactinea*), the basidia are succeeded at the end of the rainy season by hyphal elongations which grow out from the hymenium and develop terminal spores (*i.e.* secondary basidiospores). I then expressed the hope that in course of time many more species of Polyporaceae would be found to exhibit the same mode of reproduction by secondary spores without basidia after the rains or during intervals between two showers in the rainy season. Since then, I have extended my observations to other species of Polyporaceae (*Polyporus zonalis, P. ostreiformis, P. rubidus, P. gilvus, P. anebus, Polystictus sanguineus, P. versicolor, P. hirsutus, P. xanthopus, P. personatus, P. protea, Trametes cingulata, T. badia, T. cubensis, T. Persoonii, T. floccosus, Fomes senex, F. pectinatus, Favolus scaber*) in addition to those mentioned above. In all these species I have found that, at the end of the rainy season and at intervals between two showers of rain, the basidia are themselves gradually transformed into hyphal elongations with terminal spores which are exactly like the basidiospores; in two instances (*viz. Trametes lactinea* and *Polystictus protea*) I noticed that there was copious spore-fall from such hyphal elongations on the surface of the agar in an agar plate. These elongations may be regarded as paraphysoid hyphae or cystidia with "pseudoconidia" or "basidioconidia" at the tips. Conversely, if showers of rain come in the middle of the dry season, the hymenial elongations soon become reconverted into basidia; a preliminary note has been published in *Nature* (Bose, **1940**).

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Pieces of the sporophores of various Polyporaceae were attached to a lid of a petri dish containing 2.5 per cent agar, and the spore-deposit on the surface of the agar was examined daily. In many cases I have found that after the spore-fall has completely

FIG. 1.

ceased and the agar-plate has become comparatively dry, the pieces of sporophores when sectioned show pore-tubes in which basidia have been almost completely replaced by hyphal elongations, all these elongations having distinct clamp-connexions at their bases (FIG. 8:1) and some bearing rudimentary spores at their apices (FIG. 8:2). During the rainy season it is not uncommon to come
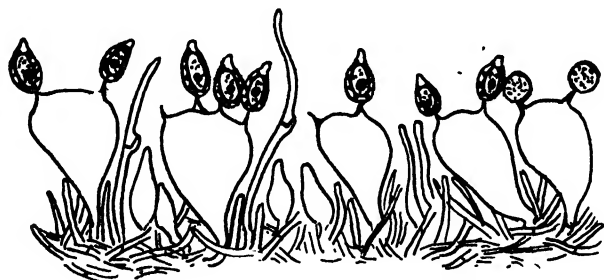
FIG. 2.

across specimens of *Ganoderma lucidum* collected on the same day which show in their pore-tubes intergrading stages between regular basidia and hyphal elongations with terminal spores; for instance, on the 28th of July, 1937, three specimens of *G. lucidum* were collected from the field, of which one had a preponderance of hyphal elongations with secondary spores (FIG. 1), while the other two had preponderance of basidia (FIG. 2, 3). This is probably be-

cause specimens growing in nature during the rainy season are not equally exposed to the rains. During the dry season (*e.g.* the months of May, September, October, November, December) normal basidia (10 to 11 μ broad) are often found in pore-tubes of specimens of *G. lucidum* and *G. applanatum* growing in nature, intergrading into beaked narrower basidia (4 to 9 μ broad) and finally into clamped and elongated hyphae with terminal mature brown spores which are indistinguishable from the normal basidiospores (FIG. 4). These represent gradual stages in the transformation of basidia into hyphal elongations with terminal spores, according to the season. On fixing a piece of fresh and moist sporophore of *Ganoderma* (*G. lucidum* and *G. applanatum*) from the field during the rainy season to the lid of an agar-plate placed
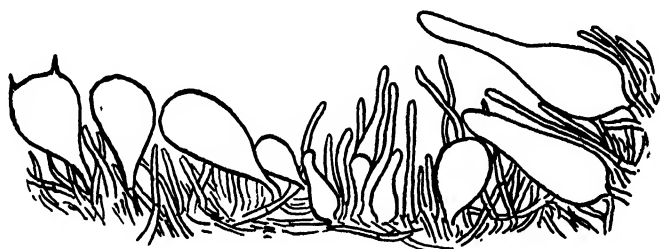
FIG. 3.

within a desiccator containing sulphuric acid at about 80 per cent relative humidity and slicing off a portion each day for examination, the gradual conversion of basidia into hyphal projections with terminal rudimentary spores could be distinctly followed in the course of the second or the third day (FIG. 5), but usually there was no spore-fall in such cases. Such conversion into hyphal elongations with clamp-connexions and terminal spores I could, by similar treatment, follow at about 80 to 85 per cent relative humidity in cases of fresh and moist specimens of *Polyporus ostreiformis, P. rubidus, P. luzonensis, Polystictus versicolor, Trametes cingulata, T. Persoonii, T. badia, Lenzites repanda* and *L. striata* collected from the field in July, August and September 1938 (*i.e.* the rainy season). The preliminary stages of gradual conversion of the normal basidium with four rudimentary sterigmata (FIG. 6 *a*) into narrow and short hyphal elongations are depicted in figure 6,

where it is shown how the basidial apices become narrower and the sterigmata become approximated as thinner and longer stalks bearing abortive spores (FIG. 6 *b–d*), ultimately only one of these stalks (FIG. 6 *e–h*) elongates, while others lag behind and are gradually shed.

On examination of a very large number of sections of fresh specimens of several Polyporaceae during the successive rains for a number of years since 1931, I find that it is mainly the water-relation which controls the transformation of basidia into hyphal elongations with clamp-connexions and terminal spores and its

Discharged spores germinating
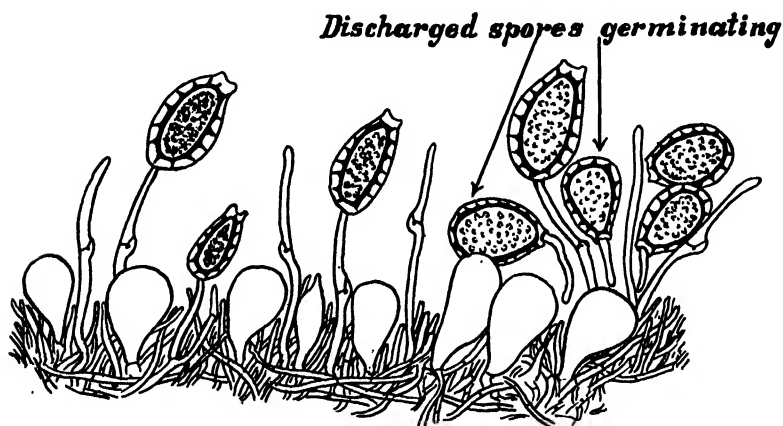
Fig. 4.

reversal. Experimentally I tried such conversion in March and April 1938 and also subsequently in 1939 in the following way:—

A piece of dry sporophore of thin *Polystictus sanguineus* collected from the field about a month previously was put under the water-tap of the laboratory sink in the diffused light of the room, the water dripping in a continuous shower for eighteen hours [1] through a perforated thimble attached to the water-tap. The sporophore originally had pore-tubes full of immature basidia (without sterigmata and spores), and in some pore-tubes there were a few hyphal elongations; but being kept under running water for eighteen hours the hyphal elongations entirely disappeared by way of gradual loss of protoplasm from the apex and of shedding of dead

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[1] This period has been found to be different for different species.

parts (FIG. 7), and the majority of the pore-tubes developed mature basidia with sterigmata and spores (FIG. 8:3). Another piece of the same sporophore was attached to the lid of an agar-plate and was sectioned daily; for the first two or three days when the relative humidity [2] was about 97 per cent, there was copious spore-fall on the agar-surface and pore-tubes showed normal mature basidia ($10–12 \times 5–6\,\mu$) in a row; but as the water of condensation gradually disappeared from the plate and it became comparatively dry in the course of three or four days, the relative

Discharged spore germinating

FIG. 5.

humidity being brought down to about 85 per cent, the spore-fall became scanty and pore-tubes displayed a development of a large number of clamped and elongated hyphae with terminal spores and of a few deformed basidia which were much longer and narrower than the normal ones (about 18 long and $2–3\,\mu$ broad) (FIG. 8:4, 5). Now the two pieces were reversed in position, *i.e.*, the one under running water was dried at room temperature for a day and

was put inside an agar-plate, fixed to its lid for four days, and the other from the agar-plate was put under running water of the water-tap for a day. It was found that the piece under running water developed normal regular basidia (some with sterigmata and spores) in a row in the pore-tubes as in figure 8:3 without any hyphal elongations, while the other one inside the dry agar-plate
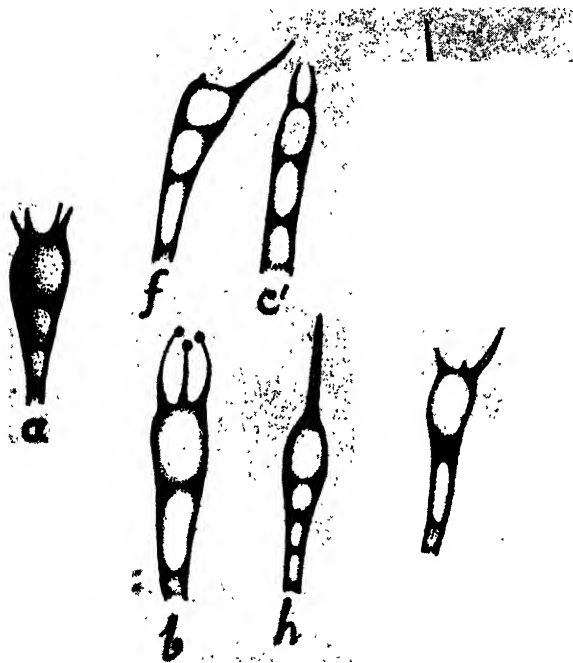
FIG. 6 *a–h*. Camera lucida sketch from two neighboring pore-tubes of the hymenial surface of *Polystictus versicolor* at about 80 per cent relative humidity under oil immersion lens with eye-piece no. 5, showing the preliminary stages of gradual conversion of the normal basidium with four sterigmata into narrow and short hyphal elongation.

showed in the pore-tubes hyphal elongations and elongated, narrower and abnormal basidia, some of the hyphal elongations having terminal spores. This experiment was repeated several times and sometimes in reverse order, and in each case the same result was uniformly obtained. The experimental conversion of basidia into hyphal elongations with clamp-connexions and with terminal spores

in some cases, and conversely, the conversion of hyphal elongations
into basidia were quite successful with thin and dry specimens of
*Polystictus sanguineus, P. hirsutus, P. versicolor, P. xanthopus,
P. personatus, P. proteus, Polyporus rubidus, P. ostreiformis,* and
Trametes cingulata collected from the field about a month pre-
viously.   In each case the result was verified by several repetitions.
The conversion did not succeed well with very thick or soft speci-
mens of *Polyporus, Trametes, Lenzites, Daedalea, Fomes,* etc.;
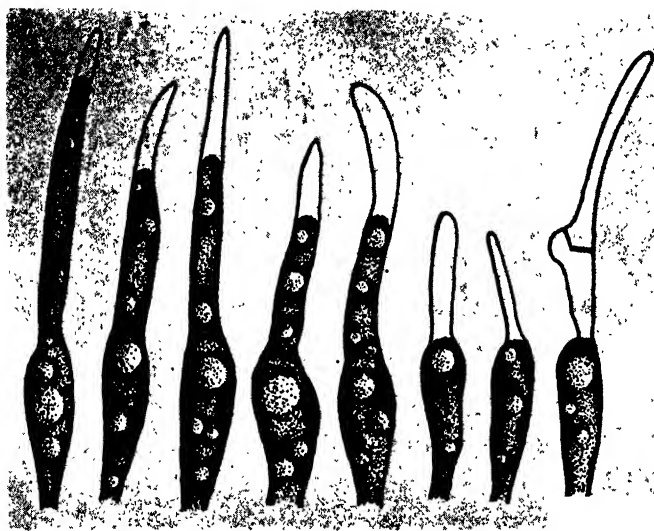
FIG. 7.   Camera lucida sketch, under oil immersion lens and eye-piece no.
5, of hyphal elongations showing gradual loss of protoplasm from the apex.

and it was also noticed that if the spore-fall in moist condition
within an agar-plate were too prolonged, the hyphal elongations
could not be reconverted into basidia under the water-tap and the
whole piece in such case decayed.   In the case of *Ganoderma lu-
cidum* and *G. applanatum,* however, success, *i.e.* the transformation
of hyphal elongations into regular basidia in a row, was attained in
October, 1935, by keeping the entire log with attached fruit-bodies
under the water-tap for two days and in the case of *Polyporus
grammocephalus* in September, 1939, for less than a day.   If
such sporophores are severed from the substratum and kept under
running water, they undergo gradual decay.   The degree of desic-

cation tolerated by various species, as is known, varies greatly; some like *Polystictus,* thin species of *Polyporus,* etc., appear capable of withstanding almost complete drying, while others, especially thick or soft specimens of *Fomes, Daedalea, Trametes, Lenzites,* etc., are not thus resistant. In this connection I have to record my personal experience of the revival of the fruit-body of *Polystictus sanguineus* after eight months' desiccation over pure sulphuric acid in a vacuum desiccator (*i.e.,* approximately at zero humidity). A piece of this desiccated sporophore, when put inside a moist agar-plate, soon began throwing out spores and continued to do so for seven days; the spores germinated easily and the germinating hyphae formed clamp-connexions in the course of two days and advanced to full development in tubes of malt-extract agar. It was further noted that a piece of the sporophore of *Polystictus sanguineus* that was kept inside a sterilized plate (without agar and at a relative humidity of about 53 per cent) even after seven days did not show any change. Similarly, specimens kept at 72 per cent and 62 per cent relative humidity over suitable concentrations of sulphuric acid for about a month, and also those kept at zero humidity as described above for *P. sanguineus,* showed no transformation and did not deposit any spores. Evidently, the humidity had been too low to permit of the conversion being effected.

The experiments just described undoubtedly give a clue to what happens under natural conditions; it indicates that, in many Polyporaceae, the amount of rainfall governs the transformation of basidia.

Regarding polymorphism of basidia, Patouillard (**1880, 1881**) recorded that in *Pleurotus ostreatus,* besides normal basidia with four sterigmata and spores, the hymenium shows cystidia with one terminal oval or globular spore or conidium. In a short paper (**1889**) he gave it as his opinion that every cell of a fruit-body is a potential basidium and, by comparison of the upper surface of the pileus with the hymenium, found complete homology between the basidia and spore-bearing hairs. Matruchot (**1897**) observed in the same species the intergrading series, numerically balancing one another, between the two preceding categories of structures observed by Patouillard, and thought that the normal basidia, hy-

menial cystidia with 1, 2 and 3 sterigmata, and extra-hymenial cystidia with pseudoconidia are but forms of one and the same type.   Richard Falck (1909) held that in *Lenzites* the fertile hyphae, if they do not attain to basidia-formation, become transformed into vegetative hyphal threads or hairy hyphae.   In the hymenium of *Spongipellis Litschaueri* Lohwag (1931) observed between the normal basidia (4–5 μ broad) bearing spores thin hyphal threads comparable to "paraphysoid hyphae," which are 2 μ broad.   He (1937, p. 165) cited a number of instances, observed by other workers besides himself, where basidia are intermixed with such hyphal hairs in the hymenial layer.   He regards them as examples of reversion of basidia to vegetative paraphyses.   But these hyphal threads or hairy hyphae were apparently without any terminal spore.   Corner (1934) held that in the fruitbody of *Collybia apalosarca* "almost every apical cell on cessation of growth enlarges into a basidium or a cystidium."   Heim (1933) found in the pore-tubes of *Xanthochrous Patouillardi* Rick. var. *congoensis,* besides normal basidia with four sterigmata, elongated hyaline tramal hyphae bearing at their apices spores indistinguishable from the normal basidiospores.   Heim and Malençon (1933) held that in *Lycoperdellon Torrendii* Bres., where basidia and basidiospores are not formed under favorable circumstances, "basidioconidia" which are different from the real conidia, usually appear; but they did not investigate further the nature of the unfavorable circumstances.   At one place (at p. 14) they surmise that such secondary basidiospores ("basidioconidia") probably arise as a result of the functional derangement of the basidium, especially its nuclear phenomena.   In the case of *Ganoderma,* I (1935) have found that the nucleus of a secondary basidiospore arises by amitosis from the fusion-nucleus of the apical cell of the hyphal elongation, and I have illustrated the successive stages as seen in fixed and stained preparations.   By growing *Polyporus squamosus* in complete darkness Oehm (1937) obtained an irregular chlamydospore-fruitbody in which basidia failed to develop but hyphae bore chlamydospores, sometimes in chains, with clamy-connexions; these spores were brown, bigger than the normal basidiospores, and did not germinate in the various media tried.   Such sporophores were regarded as sterile, resembling outwardly the dark form of *Lentinus squamo-*
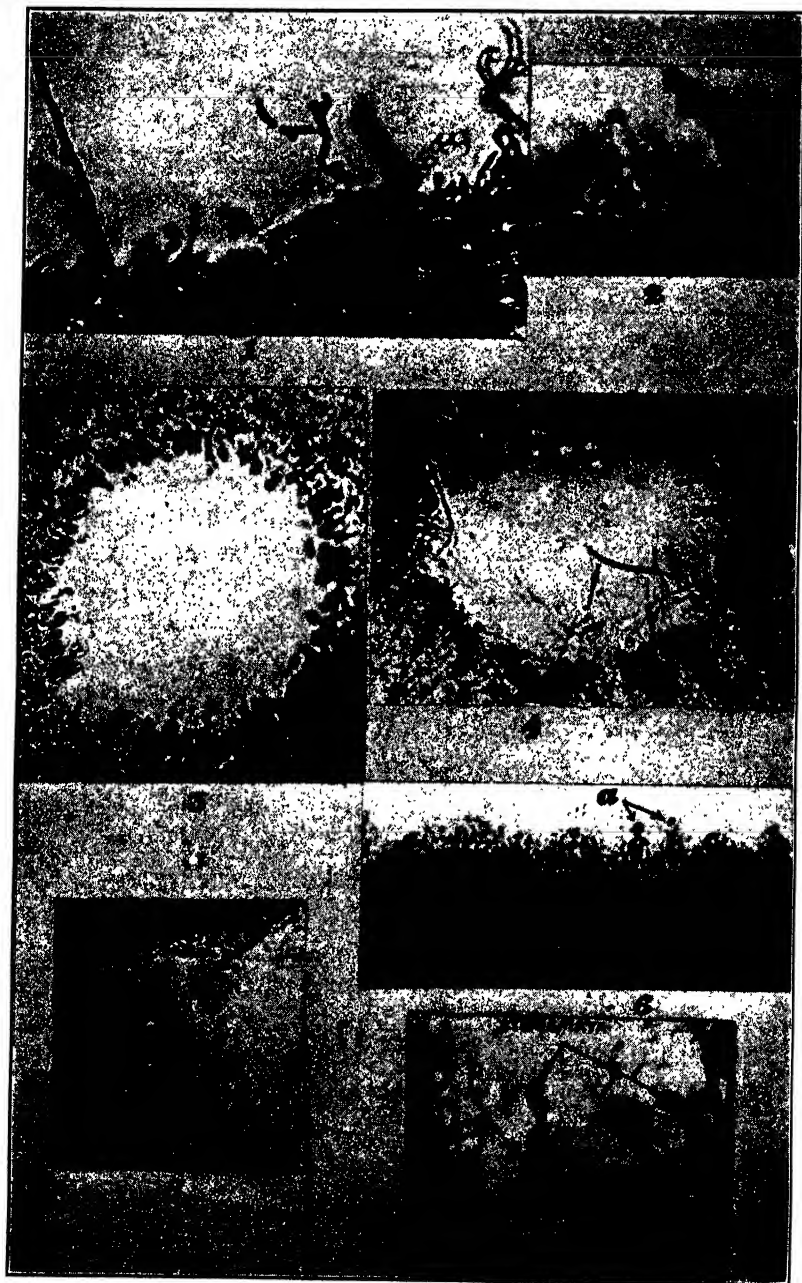
Fig. 8.

sus. In some members of the Agaricaceae French mycologists, such as Josserand (**1937**) and others, have from time to time in the *Bull. Soc. Myc. France,* described and illustrated probasidia, various forms of cystidia (cheilocystidia, pleurocystidia, etc.) and basidial proliferations mixed with the normal basidia as hyphal elongations; but these structures are never terminated by secondary spores.

The workers cited above have in no instance correlated this change of form of basidia with varying external conditions, that is, they have not noted the external conditions under which such change takes place. In India where, unlike Europe, there is usually a well-marked rainy season, I have readily followed these changes during the successive rains since 1931, and the water-tap experiment and the "agar-plate-technique" have fully corroborated my field observations. I have always found that in the pore-tubes where there is a preponderance of basidia the hyphal elongations are few, and that when the hyphal elongations preponderate basidia are very scarce.

Montgomery (**1936**) obtained in sections of the pore-surface of *Fomes fraxineus* in culture typical basidia bearing four basidiospores. "This," he states, "is contrary to the observations made in the same species by Baxter (**1925**) who reports that only secondary spores were produced in the pores. None of these secondary spores were seen by the author." This apparent contradiction between the observations of Baxter and of Montgomery on *Fomes*

Fig. 8. All the microphotographs were taken under Zeiss apochromat 2 mm. oil-immersion lens N.A.1.4 and eye-piece no. 5. 1, pore-tube of *Polystictus sanguineus* showing a large number of hyphal elongations with clamps; 2, hyphal elongations with terminal rudimentary spores in the pore-tube of *Polystictus hirsutus;* 3, pore-tube of *Polystictus sanguineus* kept under running water for 18 hours showing development of mature basidia with sterigmata and spores and almost total disappearance of hyphal elongations; 4, transverse section of a pore-tube of *Polystictus sanguineus* from dry agar-plate showing development of a large number of clamped and elongated hyphae and of some deformed (narrower and longer) basidia; 5, longitudinal section of a pore-tube of *Polystictus sanguineus* from the dry plate as in figure 4; 6, hymenial layer of an abnormal *Ganoderma lucidum* showing brown thick-walled basidia some of which have rudimentary spores (a) emerging out of a germ-pore-like area; 7, portion of a pore-tube of an abnormal *Ganoderma lucidum* showing elongated, thick-walled and brown basidia with vacant sterigmata.

fraxineus (not available in India) admits, in view of my experi-
ences with more than a dozen Polyporaceae, an easy explanation.
Neither Montgomery nor Baxter recorded the condition in their
respective culture-tubes.   It is, therefore, very likely that Mont-
gomery's culture-tubes were in a moist condition when the pore-
tubes would be full of basidia, while Baxter's had been kept
comparatively dry when basidia would be replaced by hyphal
elongations.

Incidentally, in some specimens of *Ganoderma lucidum* growing
on roots of the stump of a dead coconut palm in August 1937 and
July to October 1938 at Dum Dum (Calcutta), and on the trunk
of a living *Diospyros embryopteris* tree at Belgachia (Calcutta) in
August 1938, I observed some *pseudobasidia* in the hymenial layer
similar to those figured and described by Heim (**1932, 1932**(a))
in *Podaxis indicus* and *Podaxis aegyptiacus* and cited by Lohwag
(**1936**).   They were thick-walled and brown in colour like the
spores situated among the normal basidia and had at the apex, in
some cases, a thin area like a germ-pore through which a rudi-
mentary spore emerged (FIG. 8: 6), while others had vacant sterig-
mata (FIG. 8: 7).   Heim regards such pseudobasidia or hyper-
tropied basidia as equivalent to macrospores or giant spores.   Ac-
cording to him their formation is due to acceleration of sporulation
under the influence of unfavorable climatic or nutritive conditions,
resulting in the formation of spores before the maturation of
basidia.   Unfortunately, the conditions to which he refers are
vague and indefinite.

SUMMARY

Basidia of many Polyporaceae at the end of the rainy season and
during intervals between two showers of rain have been observed
to be gradually transformed into hyphal elongations with terminal
spores that are exactly like basidiospores.   Conversely, on the
advent of rain in the middle of a dry season, the hyphal elongations
soon become reconverted into regular basidia.

Such conversion has been reproduced under experimental con-
ditions.   When a piece of the fruitbody of a thin and desiccated
specimen was placed under the running water of a laboratory-tap
overnight, the hyphal elongations entirely disappeared from the

pore-tubes and the majority of the pore-tubes developed mature basidia with sterigmata and spores. When a piece of the same fruitbody was stuck to the lid of a moist agar-plate and examined daily under the microscope, it was found that, as the water of condensation gradually disappeared from the plate in the course of three or four days and the plate became comparatively dry (the relative humidity becoming reduced to about 85 per cent), the pore-tubes displayed a development of a large number of clamped and elongated hyphae with terminal spores and a few abnormal elongated narrower basidia. The experiment was repeated several times and sometimes in reverse order, and in each case the same result was obtained. Such experimental conversion was quite successful with thin and easily desiccated specimens of *Polyporus, Polystictus,* and *Trametes.* It did not succeed well with very thick or soft specimens of *Polyporus, Trametes, Lenzites, Daedalea, Fomes,* etc., as it is known that all specimens cannot withstand desiccation to the same degree. This experiment confirms my observation that it is mainly the water-relation which controls the transformation of basidia into hyphal elongations with clamp-connexions and terminal spores and *vice versa.* None of the previous workers (Patouillard, Matruchot, and Heim) have correlated this change of form of basidia with the varying external conditions.

In some specimens of *Ganoderma lucidum* collected in 1937 and 1938, brown thick-walled basidia resembling those described by Heim in *Podaxis indicus* and *Podaxis aegyptiacus* under the name of *pseudobasidia,* were found in the hymenial layer.

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BIBLIOGRAPHY

Baxter, D. V. 1925. Papers Mich. Acad. Sci. 4: 55.
Bose, S. R. 1935. Phytopathology 25: 426.
——. 1940. Nature 145: 706.
Corner, E. J. H. 1934. Trans. Brit. Myc. Soc. 19: 39.
Falck, R. 1909. In Möller, Hausschwammforschungen, Heft 3.
Heim, R. 1932. Compt. Rend. Acad. Sci. Paris 194: 1182.
——. 1932(a). Bull. Museum 4: 915.
——. 1933. Ann. Crypt. Exot. 6: 143.

Heim, R. & Malençon, G. 1933. Rev. Générale Bot. **45**: 53.
Josserand, M. 1937. Bull. Soc. Myc. Fr. **53**: 175.
Lohwag, H. 1931. Arch. Protist. 75.
——. 1936. Ann. Myc. **34**: 275.
——. 1937. Ann. Myc. **35**: 157.
Matruchot, L. 1897. Rev. Générale Bot. **9**: 80.
Montgomery, H. B. S. 1936. Ann. Applied Biol. **23**: 465.
Oehm, G. 1937. Beih. Bot. Centralb. **57**: 264.
Patouillard, N. 1880. Bull. Soc. Bot. France **27**: 125.
——. 1881. Rev. Myc. **3**: 10.
——. 1889. Bull. Soc. Myc. Fr. 5.

DISTRIBUTION OF ANTAGONISTIC FUNGI IN NATURE AND THEIR ANTI-BIOTIC ACTION [1]

SELMAN A. WAKSMAN AND ELIZABETH S. HORNING

(WITH 7 FIGURES)

The ability of many fungi to antagonize various microörganisms, notably bacteria and other fungi, has been well established, as brought out in several recent reviews (6, 11). In most cases, attention has been centered upon the antagonistic action of various fungi against organisms capable of causing plant diseases (4, 6, 15, 8). Fungi capable of antagonizing pathogenic organisms belonging to the groups *Ophiobolus, Rhizoctonia* and *Fusarium* have been studied most extensively.

It has been demonstrated in recent studies that fungi capable of inhibiting the growth of bacteria are distributed among various taxonomic groups. The following organisms have so far received the greatest attention as agents possessing bacteriostatic and bactericidal properties: 1. The *Penicillium notatum* group, from which Fleming (3) and, later, other British investigators (9, 1) isolated an active substance, designated as penicillin; 2. other species of *Penicillium,* including *P. citrinum* and *P. cyclopium,* from which Raistrick and associates (10) isolated respectively *citrinin* and *penicillic acid,* substances possessing some antibiotic properties; 3. the *Aspergillus flavus* group, from which White (16) and Glister (5) isolated active substances; 4. the *Trichoderma* and *Gliocladium* groups, from which Weindling (15) isolated an antibiotic substance designated as *gliotoxin.*

In spite of the fact, however, that many fungi were thus found to be capable of depressing and even gradually destroying the growth of many bacteria, no systematic study has so far been made of the occurrence and distribution of such antagonistic or-

ganisms in nature. Virtually all previous investigations were based either upon chance contaminants developing on bacterial plates exposed in the laboratory or upon results obtained by testing cultures taken from collections. The wide distribution of antagonistic bacteria and actinomycetes in natural substrates, such as soils and composts, suggested the possibility that antagonistic fungi also occur in these substrates. This and the fact that their development might be stimulated by various treatments led to a systematic survey of the occurrence and activities of these organisms.

SUBSTRATES FOR THE ISOLATION OF ANTAGONISTIC FUNGI

When bacteria are added to soil, to sewage or to composts of plant residues, they are rapidly destroyed by antagonistic organisms, which are able to develop at their expense (2, 12, 13). Under natural conditions, these substrates continuously receive large numbers of bacteria, either by the introduction of foreign materials rich in bacteria (animal droppings, stable manure, garbage), or as a result of the stimulated multiplication of bacteria caused by various treatments. One would expect, therefore, that stable manures and soil should be the logical sources for the isolation of antagonistic organisms, including fungi, especially since these organisms grow much better in soils and in composts than, for example, in sewage. These substrates were largely used, therefore, in this investigation. A series of soils, differently treated with manures and fertilizers, were selected from the experimental fields of the New Jersey Agricultural Experiment Station; stable manures and composts prepared from various plant materials were also employed.

METHOD OF ISOLATION OF ANTAGONISTIC FUNGI

The selection of suitable methods for the isolation of antagonistic organisms is very essential. If a material, such as soil, sewage or manure, is plated out on ordinary organic or synthetic media, in the dilutions commonly employed for the enumeration or isolation of bacteria, the chances of obtaining fungi, especially antagonistic forms, are rather remote. When these media are acidified to a pH of 4.0 or 4.5, the development of the majority of bacteria is
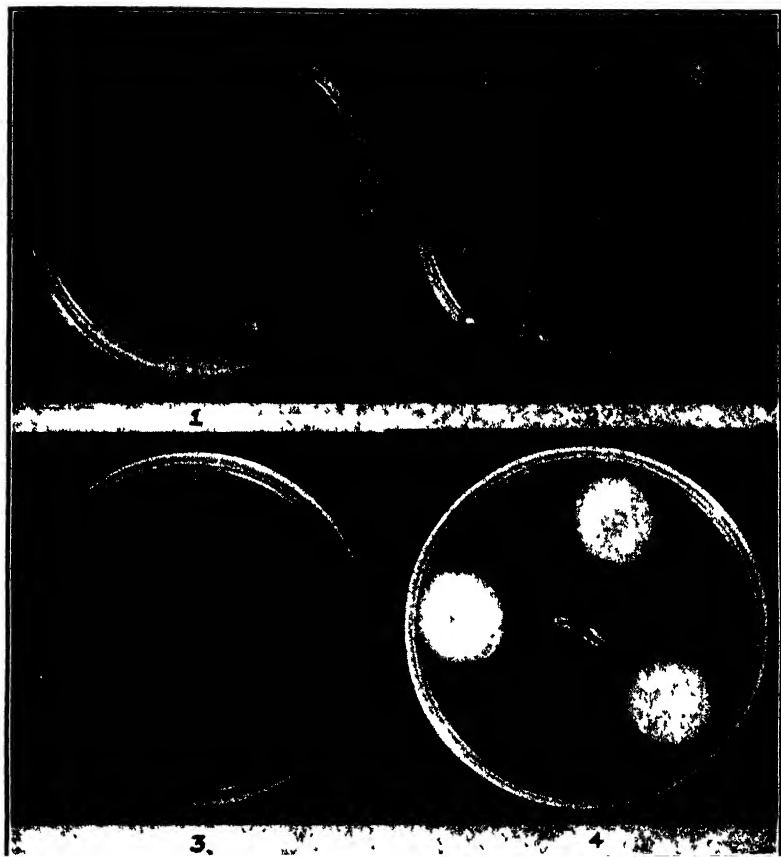
FIGS. 1–4. Isolation of antagonistic fungi and testing their anti-bacterial properties.

inhibited, but most of the fungi are still able to grow. By using these acid media, it is possible to plate out lower dilutions, enabling fungi to develop without the numerous bacterial colonies obtained on the ordinary plates. After 2 days incubation at 28° C., the fungi can readily be isolated from the colonies formed on these plates. Since there is no evidence that these fungi possess properties antagonistic to bacteria, all the colonies must first be isolated and tested. This tends to make the procedure both tedious and difficult, without the required assurance that many antagonistic types will be obtained. Fortunately, other and more suitable methods have been developed and can now be employed.

The following general procedures for the isolation of antagonistic fungi from soils and other materials have been utilized in this investigation: 1. Suitable agar plates are seeded with various bacteria; these are allowed to develop for 12–24 hours, and the plates inoculated with small particles of soil or manure.   2. Washed suspensions of different living bacteria are added to washed agar containing a carbohydrate and some phosphate; this bacterial agar is used for plating out the soil or the manure. The following modification of the second procedure was used in most of this work.   Two to three day old cultures of *Bacillus subtilis, Sarcina lutea, Staphylococcus aureus* and *Escherichia coli* grown on agar or in liquid media are suspended in sterile water, centrifuged, washed, again centrifuged and fairly heavy suspensions of the bacteria in sterile water added to washed agar, enriched by 1 to 3 per cent glucose and 0.05 to 0.1 per cent KH_2PO_4. The reaction of the medium is thus slightly acid, making it highly favorable to the development of antagonistic fungi. The soil or manure is plated out on the above agar in dilutions of 1 : 500, 1 : 2,000 and 1 : 10,000, and the plates are incubated for 2–4 days at 25–28° C. The antagonistic fungi produce colonies surrounded by clear zones, as shown in figures 1–2, as a result of the dissolution of the bacteria on the plate.   These colonies are picked, by cutting out bits of mycelium, and transferred to plates of sterile glucose-peptone agar.

Before a specific fungus culture is designated as an antagonistic organism, it is further tested by two specific methods: (*a*) The pure culture is inoculated upon the washed agar medium enriched with living *S. lutea* or *B. subtilis* cells; cultures possessing antagonistic properties are surrounded by clear zones, free from bacterial cells (FIG. 3).   (*b*) Two to four fungi are "spot" inoculated upon solidified glucose-peptone agar plates and incubated at 28° C., for 20 to 24 hours, to enable the spores of the fungi to germinate or the mycelium to develop and form small colonies; an aqueous suspension of *B. subtilis* or *Staphylococcus aureus* is streaked from the center of the plate to the edge of the growing colony and the plates are incubated for 24 hours at 28° C. if *B. subtilis* is used or 37° C. if *S. aureus* is used; the formation of antibiotic substances by the fungus is detected by the presence of a clear zone between

the fungus colony and the growth of the test organisms (FIG. 4). The clear zones vary in width from 1 mm. to 3 cm. Those fungi which produce the widest zones of bacterial inhibition or of bacteriolysis and thus appear to be decidedly antagonistic are selected for further studies.

These procedures for the isolation and testing of antagonistic fungi proved to be very convenient, especially when it was necessary to isolate and test a large number of fungi within a short time. It is, of course, possible that the fungi which showed only limited antagonism to the particular test bacterium may prove to be much more active against other organisms, because of the known selective action of microbial antagonists. The use of other media might have modified the nature of the fungi thus obtained. In spite of these limitations, however, it was possible to isolate a large number of fungi which possess anti-bacterial properties in varying degrees.

The fungus colonies that were thus selected for antagonistic properties by one of the above methods, were now isolated from the test plates and transferred to sterile agar media. In many cases, the cultures thus obtained were not pure, but represented mixtures of two or more different organisms. These were now separated by replating and isolating individual colonies. The fresh cultures were often retested for their antagonistic action.

THE PRODUCTION OF ANTIBIOTIC SUBSTANCES BY ANTAGONISTIC FUNGI

After the fungi have been isolated from the plate and grown in pure culture, they were studied further for the production of antibiotic substances in liquid media. Various organic and synthetic media were used for this purpose. The one most commonly employed is the nitrate-glucose solution, or the so-called Czapek-Dox medium. Although the addition of yeast extract, corn steep liquor, or brown sugar was found to be highly favorable to the production of penicillin and some other antibiotic substances, in most cases they were quite superfluous or even injurious to the production of various other antibiotic bodies.

A shallow layer of medium (60–100 ml. per 250 cc. Erlenmeyer flask or 100–250 ml. per 1 liter flask) was found to be most satis-

factory. In some cases, however, deeper layers resulted in the production of some rather interesting antibiotic substances. It was found, for example, that certain strains of *P. notatum* produce a factor active against *E. coli* when grown in much deeper layers of medium (150–175 ml. per 250 cc. flask or 600–700 ml. per 1 liter flask). The cultures are usually incubated, for 7–10 days, at 25–28° C. Because of differences in the rates of growth of various antagonistic organisms upon different media, the optimum period of incubation may vary from 4 to 15 days. This is particularly important if the fact is recognized that different fungi may produce several active substances, selective in their action against various bacteria. These substances need not appear simultaneously in the medium, but may appear and disappear at different periods of incubation.

The culture filtrates of the antagonistic fungi are now tested for antibiotic activity, by one of several procedures: 1. different volumes (1.0–0.001 ml.) of the filtrates are added to 5 or 10 ml. portions of sterile liquid broth; this is inoculated with the test organism and incubated. Absence of growth of the test organism, as determined by streaking, or by plating on sterile agar media, or by a change in turbidity, is taken as the end point; 2. varying amounts of the filtrate of the antagonist are incorporated into nutrient agar and the plates are streaked with 2 to 4 test organisms. Positive or negative growth of these give the limit of activity or the concentration of the active substance in the filtrate; 3. solid media are inoculated with one test organism and treated with varying amounts of the active filtrate; this is either incorporated directly into the medium or allowed to diffuse through it from a central point. The reduction in the number of bacterial colonies or the width of the zone of inhibition of bacterial growth is taken as a measure of the activity of the culture filtrate.

Each of the above methods has its advantages and disadvantages. For the study of substances which have bacteriolytic properties, the first is most convenient. Sterility of the materials used in making this test is essential. The second method is most convenient for a rapid survey of a number of organisms. It has the added advantage that several test organisms can be streaked on the same plate; however, it does not yield accurate quantitative results. The third

method, of which several modifications exist, such as the Oxford method (1), readily lends itself to a quantitative expression of the concentration of the active substance and does not require sterile material. Only one test organism can be used, however, and the method itself is rather cumbersome.

Since it was essential, in carrying out this survey of the occurrence of antagonistic fungi, to determine the specific effects of a large number of fungi against a variety of bacteria, the second method was found to be most suitable. Since most of the antibiotic substances produced by microörganisms are selective in their action, not only against gram-positive vs. gram-negative bacteria, but also against specific organisms within each group, this method proved to be particularly useful. In most instances, four test organisms were used in determining the antibiotic activity of the unknown active substance in each culture filtrate. The units of activity can best be expressed by the ratio of the dilution of the culture filtrate added to the agar to the volume of agar used in the plate. The highest dilution which gives complete inhibition of growth of the test organism was taken as the end point. If growth was not fully but only partly inhibited, the inhibiting dilution was interpolated between that giving reduced growth and that giving no growth at all. The period of incubation of the plates was found to be significant. Ordinarily, 24 hours incubation at 28° C. was used for *B. subtilis, B. mycoides, E. coli,* 24 hours at 37° C., for *S. aureus,* and 48 hours at 28° C., for *S. lutea.* In most cases, the tests did not change on further incubation of the plates, though in some cases the activity tended to be reduced or even completely disappeared when the plates were incubated for a day or two longer. This points either to the destruction of the active substance on continued incubation, or to the gradual adaptation of the test organism to the substance. Certain fungi tend to produce substances that are active for only a short time.

ISOLATION OF SPECIFIC ANTAGONISTIC FUNGI

By the use of the above methods, 160 cultures of fungi were isolated in our laboratory from a number of soils and composts. Many of these fungi were found, by the streak method, to be active but did not produce any soluble active substances when grown in

liquid culture media.   This may be due to the fact that either these organisms produce antagonistic effects only in the presence of the living antagonists or that favorable conditions for the production and accumulation of the antibiotic substance by these organisms have not been attained.   Cultures 94, 96 and 118 are specific illustrations of that effect.   It was later found that, in some cases at least, the modification of the liquid medium or of the condition of growth resulted in the production of an active substance.

The various antagonistic fungi thus far isolated in this survey can be divided into 9 distinct groups, on the basis of the taxonomic position of the organisms.   They also appeared to vary greatly in the nature of their antibiotic activity.   These groups can be briefly listed as follows:

Group 1.   *Chaetomium* group.   Only one organism, an unidentified species of the genus *Chaetomium,* was found to belong to this group.   It is listed as No. 1.   The reason for creating a separate group for this one culture was governed by its systematic position.

Group 2.   *Aspergillus fumigatus* group.   This group was found to comprise a large number of strains, isolated from different substrates.   These strains were found to possess antagonistic properties varying considerably in degree.   Morphologically, the various strains did not appear to be very different.   Some were antagonistic not only to bacteria but also to certain fungi.   Fifteen strains belonging to this group have thus far been isolated, namely, Nos. 14, 20, 26, 35, 84, 85, 87, 88, 92, 93, 97, 101, 102, 106, 107.

Group 3.   *Aspergillus clavatus-A. glaucus* group.[2]   Two strains of *A. clavatus* were isolated from manure composts, namely, 129 and 130, differing somewhat in activity.   One strain of *A. glaucus* was isolated from the soil.

Group 4.   *Aspergillus flavus* group.   Among the many strains of fungi thus far isolated, only one appeared to fall into this group (No. 136).   The organisms of White (16) and of Glister (5) also belong to this group.

Group 5.   *Penicillium luteum-purpurogenum* group.   A number of species of *Penicillium* were isolated and found to possess an-

[2] Dr. E. L. Spencer assisted in the isolation of this group, as will be reported elsewhere.

tagonistic properties. The various cultures could be divided, for convenience, into two groups; namely, 5 and 6. Group 5 comprises the following strains: 12, 108a, 108c, 109, 110, 111, 113, 114, 115, 116, 118, 119, 125, 140, 142, 146, 126, 132, 134, 138.

Group 6. Green-*Penicillium* group. This is a large heterogeneous group of organisms, including a number of forms varying greatly in activity, namely, Nos. 94, 96, 99, 108b, 117, 120, 121, 123, 124, 126, 127, 128, 132, 134, 135, 138, 139, 141, 161, 162, 163. The highly active *P. notatum* also belongs to this group. Three strains (W, F, O) of this organism were obtained from various laboratories and may also be listed here.

Group 7. *Trichoderma* group. Although members of this group were found by Weindling (15) to comprise organisms with pronounced antagonistic properties, especially active against fungi, only two strains were isolated in this study (Nos. 86, 160). These strains were not found to be very active against the test bacteria, at least under the conditions of study. No attempt was made to create special conditions for the production and isolation of the active substance.

Group 8. *Fusarium-Cephalosporium* group. The organisms belonging to this group did not readily produce any antagonistic substances when grown upon the liquid medium. Some of the cultures isolated, however, appeared to be decidedly antagonistic. This antagonistic effect often disappeared after prolonged incubation of the test organisms. The following isolated strains were found to belong to this group: Nos. 82, 83, 90, 91, 95, 98, 100, 103, 104, 105, 131, 133, 137, 143, 144.

Group 9. Miscellaneous group. A number of other organisms with various antagonistic properties were isolated from soils and composts. They have either been only incompletely identified or were insufficiently studied.

It is of interest to note that none of the Phycomycetes is included among the above groups. No species of *Mucor* or *Rhizopus* were so far isolated as antagonists by the use of the above methods. Six cultures of known species of *Rhizopus* were tested for antagonistic properties by the plate method, using *B. subtilis* as the test organism. They all gave negative results. No species belonging to the Basidiomycetes were isolated on the plate, possibly

for the simple reason that the above method did not readily lend itself to the development of these organisms.

A number of the fungi thus isolated and representing the various groups of antagonists were now tested for the production of antibiotic substances in liquid media.   The results, reported in Table 1, show that these antagonistic fungi vary considerably in activity, at

TABLE 1

ANTIBIOTIC ACTIVITY OF DIFFERENT FUNGI FRESHLY ISOLATED FROM SOILS AND OTHER NATURAL SUBSTRATES

Group No.	Organism	Age of culture. days	pH	Activity[2]		
				B. my-coides	B. sub-tilis	S. lutea
1	*Chaetomium* sp.	6	6.0	6	100	250
1	*Chaetomium* sp.	9	6.3	3	20	>300
2	*A. fumigatus* 20	9	7.8	>30	10	>300
2	*A. fumigatus* 35	9	7.6	>30	6	>300
2	*A. fumigatus* 84	9	7.8	100	30	>300
2	*A. fumigatus* 93	9	7.9	60	30	>300
2	*A. fumigatus* 107	9	7.5	>100	30	>300
3	*Fusarium* sp. 95	9	4.5	0	0	Tr.
3	*Fusarium* sp. 103	7	7.1	0	Tr.	Tr.
4	*P. luteum-purpurogenum* 108	6	3.8	10	20	50
4	*P. luteum-purpurogenum* 12	8	—	3	10	10
4	*P. luteum-purpurogenum* 113	8	—	3	10	15
4	*P. luteum-purpurogenum* 116	8	4.8	6	6	10
4	*P. luteum-purpurogenum* 119	8	3.5	0	3	10
5	Green *Penicillium* group 99[1]	8	—	.10	200	60
5	Green *Penicillium* group 115	8	—	0	20	20
5	Green *Penicillium* group 117	8	—	6	10	20
5	Green *Penicillium* group 121	8	—	13	30	—

[1] After 48 hours incubation of test organisms little inhibiting effect was produced.

[2] Unit of activity = $\dfrac{10}{\text{Amount of culture necessary to inhibit growth of test organism in 10 ml. nutrient agar}}$.

least in their ability to produce active substances in a given medium. Very few of the culture filtrates of these fungi were active against *E. coli*.   However, when the active substances produced by some of these organisms were concentrated, more were found to be active against *E. coli* and other gram-negative bacteria than was indicated by the original culture filtrate.

The various antagonistic fungi thus isolated from soils and composts were found to differ markedly in activity, qualitatively as well as quantitatively.   Some of the strains, such as Nos. 20 and 84,

were much more active against *B. mycoides* than against *B. subtilis;* others, such as 108a and 132, were inactive against *B. mycoides,* or were less active against this spore-former than against *B. subtilis.* Some were found to be only weakly antagonistic, whereas others were very strong antagonists. Some produced antibiotic substances which could readily be isolated from the medium by the use of various solvents; with others, ordinary extraction or adsorption procedures have given rather unsatisfactory results.

STRAIN SPECIFICITY

Many of the antagonistic fungi freshly isolated or obtained from other laboratories (such as the *P. notatum* strains) were found to comprise strains or varieties which varied considerably in their antibiotic activity. This was also true of strains isolated from the same mother culture. Some of the strains proved to be completely inactive; other strains, though possessing the same general characteristic antagonistic properties, varied greatly in certain qualitative and quantitative respects. The organism studied most extensively from this point of view was *P. notatum.* The tendency of this organism to produce variants that differ in activity has been the cause of considerable trouble in the practical production of penicillin.

Eight different strains of *P. notatum,* available in England and in this country, were collected and tested by the various methods described above. These strains differed greatly in capacity to produce the active antibiotic substance, which may or may not have been true penicillin. In order to illustrate the variation in the results obtained, only three strains need be discussed here:

1. A pre-Fleming strain of *P. notatum,* probably the original isolation made by Westling. It was received from the latter by Dr. Thom and sent by him to the Centralbureau in Holland. From there, it came, in 1925, to Dr. Raistrick in England, was deposited by him in the Lister collection in London, and was received from Dr. St. John Brooks in 1940. This strain is designated as W.

2. The original Fleming strain of *P. notatum* received from Dr. St. John Brooks in 1940, and designated as F.

3. A post-Fleming strain of *P. notatum,* presumably isolated from Fleming's original culture, brought to this country by Dr. Florey and Dr. Heatley, and obtained from the latter. This strain is designated as O (Oxford strain).

The results of a few typical experiments are reported here, in order to illustrate the differences in behavior of the different strains

TABLE 2

INFLUENCE OF COMPOSITION OF MEDIUM UPON THE ACTIVITY OF
FILTRATES OF *P. notatum*

Treatment of medium	Cul-ture of P. no-tatum	Tested by plate method[1]							
		E. coli	*B. my-coides*	*B. subtilis*	*S. lutea*	*S. aureus*[2]			
						W	H	Dp	Df
CaCO₃.......	W	20	30	100	30	30	30	30	70
CSL³........	W	0	25	30	30	30	70	30	70
CaCO₃.......	0	0	15	30	10	10	10	10	30
CSL.........	0	0	30	100	100	100	200	100	100
CSL + CaCO₃	0	0	100	100	100	80	200	80	150

[1] See table 1, footnote 2.
[2] Four different strains used as test organisms.
[3] CSL = Corn steep liquor, 6 cc. per liter.

TABLE 3

INFLUENCE OF AMENDMENTS UPON THE ANTIBIOTIC ACTIVITY
OF 2 TYPES OF *P. notatum*

Supplement	Age of cul-ture, days	Strain W				Strain 0			
		Test organism							
		E. coli	*B. my-coides*	*B. subtilis*	*S. lutea*	*E. coli*	*B. my-coides*	*B. subtilis*	*S. lutea*
No Ca.......	4	10	30	100	—	—	—	—	—
No Ca.......	9	10	10	30	30	0	10	10	10
CaCl₂[1].......	4	25	30	80	—	—	—	—	—
CaCl₂........	9	0	10	80	30	0	10	10	10
CaSO₄·2H₂O .	4	25	25	80	—	—	—	—	—
CaSO₄·2H₂O .	9	0	15	100	10	0	10	10	10
CaCO₃.......	4	25	30	100	—	—	—	—	—
CaCO₃.......	9	20	30	100	· 30	0	· 15	30	10
CSL²........	4	0	8	10	—	—	—	—	—
CSL.........	9	0	25	30	30	0	30	100	100
CSL+CaCO₃.	4	0	3	30	—	—	—	—	—
CSL+CaCO₃.	9	0	15	30	30	0	100	100	100

[1] 0.5 gm. of salt per flask, for all salts.
[2] CSL = Corn steep liquor, 6 cc. per flask.

of *P. notatum* (tables 2, 3). The effect of supplementary treatments upon the production of the active substance was found to be dependent upon the strain of the organism employed. The two strains of *P. notatum* varied not only in the amount of active substance produced but also in the nature of its activity. This is shown by the fact that, whereas the W strain produced activity against *E. coli* under certain conditions, the O strain had no activity at all against this organism. Corn steep liquor greatly improved the activity of strain O but had little effect on the general activity of strain W; however, it depressed the production of the substance against *E. coli* by this strain. The nature of the calcium salt greatly modified the nature and yield of the active substance.

TABLE 4

EFFECT OF VOLUME OF MEDIUM ON ACTIVITY OF SEVERAL
REPRESENTATIVE FUNGI

Culture No.	Volume of medium per 1 liter flask	Activity[a]			
		E. coli	*B. mycoides*	*B. subtilis*	*S. lutea*
1[1]	100	0	20	20	600
20[1]	100	0	300	150	800
20	300	0	300	60	800
84[1]	100	0	600	300	>1,000
84	300	0	300	100	>1,000
108a[1]	100	0	0	0	0
108a	300	0	0	20	10
P. notatum F[2]	100	0	3	15	—
P. notatum F	700	10	10	>100	—
P. notatum W[2]	100	0	45	70	70
P. notatum W	700	100	80	450	150

[1] Six days incubation at 28° C.   [a] See footnote 2, table 1.
[2] Five days incubation at 28° C.

INFLUENCE OF CONDITIONS OF NUTRITION UPON THE PRODUCTION OF ANTIBIOTIC SUBSTANCES

Among the various factors influencing the production of antibiotic substances by fungi, none are more important, next to the nature of the organism and the specificity of the strain, than the conditions of nutrition. A detailed study was made of the effect

of various mineral salts upon the production of antibiotic sub-
stances by *P. notatum* which may only be summarized here. The
presence of iron was found to be favorable to both the *E. coli*
factor and the general antibiotic activity of the culture. Zinc, how-
ever, even in concentration of 10 mg. $ZnSO_4.7H_2O$ per liter,
greatly reduced the antibiotic activity of the culture as a whole and
completely repressed the activity against *E. coli*. Manganese had
little effect.

The effect of volume of medium in which the organism was
grown is illustrated in table 4. Strains F and W of *P. notatum*
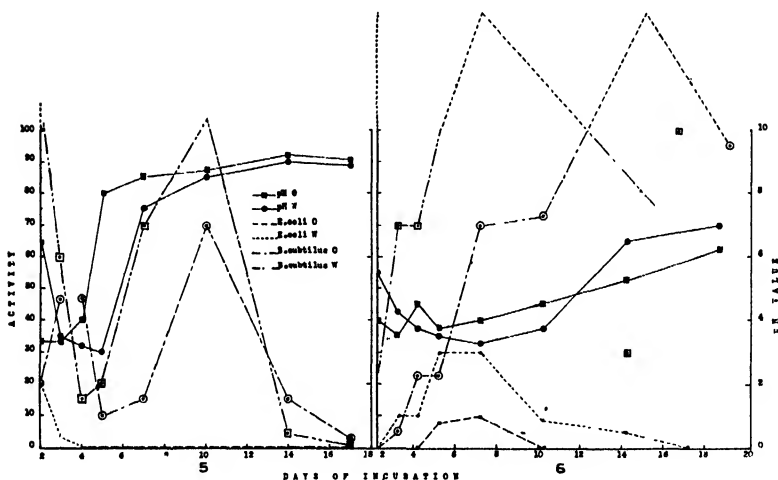
FIGS. 5–6. Course of formation of antibiotic substances by two strains
of *P. notatum* (W and O). 5, in shallow, 0.6 cm., layers; 6, in deep, 4.5
cm., layers.

were the only ones that produced an active substance against *E.
coli* in the culture filtrate, and they produced it only when grown
in deep layers of medium. The activity of two of the strains of
P. notatum and of culture 108a against all organisms was greater
in the deeper layers. Cultures 20 and 84 (*A. fumigatus*), on the
other hand, showed greater activity when grown in shallow layers.

Other factors were found to have an important influence upon
the production of antibiotic substances by various fungi. It is
sufficient to mention the effects of temperature and length of incu-
bation period. Whereas many grew well at 37° C. and even at

50° C., the optimum temperature for production of the antibiotic substances appeared to be 28° C. or even less.   Many produced the antibiotic substance at an early stage of growth, namely in 2–5 days, others required a longer incubation period for the production
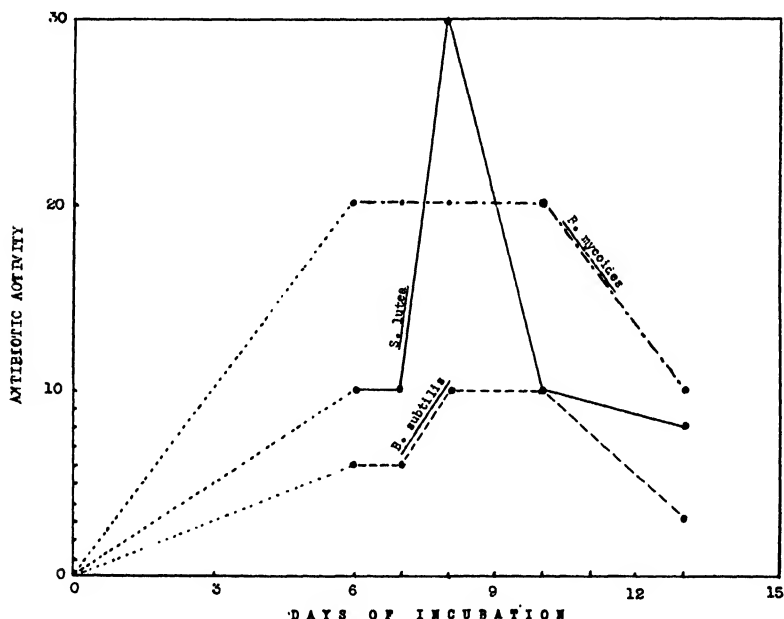
FIG. 7. Course of formation of the antibiotic substances by *Aspergillus fumigatus*. Each division represents 10 *B. subtilis* or *B. mycoides* units and 100 *S. lutea* units.

of the substance.   In the case of *P. notatum* W, for example, the *E. coli* factor appeared in 2–4 days, then rapidly disappeared, whereas the substance active against the other bacteria (penicillin) began to appear later.   This is brought out in figures 5–6.

ISOLATION OF ANTIBIOTIC SUBSTANCES FROM FUNGI

Next to the isolation of antagonistic fungi, the problem of the nature and preparation of the active antibiotic substance produced by these organisms is of the greatest importance.   Several cultures were selected for further study.   They were found to produce substances highly active *in vitro* against a great many bacteria, largely the gram-positive and certain gram-negative forms.

Various solvents were used for the isolation of the antibiotic substances from several of the new fungi. The results obtained from only one organism, namely, *A. fumigatus* strain No. 84, is reported here. This organism was found to produce an active antibiotic substance which could easily be recovered from the medium by means of certain solvents and could be concentrated. This substance, tentatively designated as *fumigacin,* was found to be markedly different from penicillin.

The course of formation of this antibiotic substance is illustrated in figure 7. The substance was found to be soluble in ether, chloroform and alcohol, and partly soluble in water. It could be extracted from the medium by the. first two reagents. Activated charcoal (norit) completely removed the substance from the medium; it could then be recovered from the norit by treatment with chloroform, or better still, by treatment with ether followed by chloroform. The following procedure was finally adopted for the isolation of this active substance:

Filtrate
(200 *B. mycoides* units and | 3,000 *S. lutea* units per 1 ml.)

Extracted with chloroform	Treated with norit Extracted with ether Extracted with chloroform
Evaporated to dryness (yield, 120 mg. of crude material per 1 liter)	Chloroform evaporated to dryness (yield, 100 mg. of material per 1 liter)
Dissolved in alcohol	Dissolved in alcohol (crystals produced on cooling)
Activity on dry basis = 20,000 *B. mycoides* and *S. lutea* units.	Activity on dry basis = 6,000,000 *S. lutea* and 1,500,000 *B. mycoides* units.

The activity of crude fumigacin against different bacteria is illustrated in table 5. It is to be recalled that Raistrick (9) isolated a quinone, designated as "fumigatin" from *A. fumigatus.* This substance has recently been shown (7) to possess antibacterial activities. Quinones in general are known to possess marked antibacterial properties. Fumigacin is markedly different from

fumigatin both in chemical nature and biological properties, as will be shown in a subsequent paper.

The production of active substances by some of the other fungi isolated in this work has also been indicated.

TABLE 5

ACTIVITY OF CRUDE PREPARATION OF FUMIGACIN AGAINST
VARIOUS BACTERIA

Test organism	Activity[1]
B. mycoides	1,500,000
B. subtilis	400,000
B. cereus	>200,000
B. megatherium	>200,000
B. brevis	>200,000
B. mesentericus	60,000
Micrococcus lysodeikticus	>200,000
Staphylococcus aureus	>200,000
Sarcina lutea	6,000,000
Brucella abortus	30,000
E. coli	3,000
Serratia marcescens	3,000
A. aerogenes	3,000
Ps. fluorescens	<2,000
Ps. aeruginosa	<2,000
Actinomyces 1	>20,000
Actinomyces 2	>20,000
Actinomyces 3	>20,000

[1] See table 1, footnote 2.

SUMMARY

Methods have been developed for the rapid isolation, from soils, manures, composts and other natural substrates, of fungi antagonistic to bacteria.   No previous enrichment of the soil with bacteria is required.

A large number of antagonistic fungi were isolated by the use of these methods.

The antagonistic nature of the organisms was first established on solid media.   The organisms were then grown in liquid media and the antibiotic activity of the culture filtrate was determined. Under the experimental conditions, some of the fungi produced such substances rapidly, whereas others showed only limited antibiotic activities.

The various antagonistic fungi thus isolated and tested were found to belong to a number of distinct taxonomic groups.   So far,

nine groups have been recognized.   Some of these groups belonging to the genus *Aspergillus* and the green *Penicillium* were particularly active; others, like the *Chaetomium* and some members of the *P. luteum* groups, had considerable activity; still others, such as members of the genera *Fusarium* and *Cephalosporium,* had very little activity.   It is quite possible that the particular media used in these studies and the conditions of growth were not the most favorable for the production of the antibiotic substances by the last group of organisms.   Active substances could readily be isolated from some of these fungi.

One of the most active fungi isolated in these studies was selected for detailed investigation, since this organism appeared to be different from all other antagonistic fungi thus far reported in the literature described above.   The various strains of this fungus, belonging to the *A. fumigatus* group, differed considerably in their activity, but they all appeared to produce the same type of antibiotic substance. · Methods were developed for the concentration and isolation of this substance.   The organism is grown in a synthetic (glucose-nitrate) medium for 5–10 days; the filtrate is treated with norit, and the active substance removed from the latter with chloroform.   The substance is soluble in chloroform and in alcohol, and partly soluble in ether and in water.   It is thermolabile in the culture filtrate; however, when removed from the filtrate and concentrated, it becomes more thermostable.

This antibiotic substance, tentatively designated as *fumigacin,* possesses characteristic antibacterial properties, which are typical of the antibiotic group of substances as a whole, namely, that they are selective in their action.   Much higher concentrations were required to inhibit the growth of *E. coli* and other gram-negative bacteria than of the gram-positive bacteria.   There was, however, considerable variation in the degree of sensitivity of the gram-negative as well as of the gram-positive bacteria.   This substance showed, in this respect, one interesting peculiarity, namely, that it was more active against *B. mycoides* than against *B. subtilis,* whereas other antibiotic substances, tested against these two organisms, showed the reverse effect.

Medium 1. Bacterial agar.
          Glucose .... 10 gm.
          KH_2PO_4 .... 1 gm.
          Washed agar .... 15 gm.
          Distilled water .... 1000 ml.

Heavy suspension of washed bacterial cells added to each tube of agar melted and cooled to 42° C.

Medium 2. Glucose-peptone or fungus agar.
          Glucose .... 10 gm.
          Peptone .... 5 gm.
          KH_2PO_4 .... 1.0 gm.
          $MgSO_4.7H_2O$ .... 0.5 gm.
          Agar .... 15 gm.
          Distilled water .. .. 1000 ml.

Medium 3. Glucose-nitrate or Czapek-Dox agar.
          Glucose .... 40.0 gm.
          $NaNO_3$ .... 3.0 gm.
          KH_2PO_4 .... 1.0 gm.
          $MgSO_4.7H_2O$ .... 0.5 gm.
          KCl .... 0.5 gm.
          $FeSO_4.7H_2O$ .... 0.01 gm.
          Tap water .... 1000 ml.

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BIBLIOGRAPHY

1. **Abraham, E. P. et al.** Lancet **241**: 177–189. 1941.
2. **Dubos, R. J.** Jour. Exp. Med. **70**: 1–17. 1939.
3. **Fleming, A.** Jour. Path. & Bact. **35**: 831–842. 1932.
4. **Garrett, S. D.** Biol. Rev. **13**: 159–185; Imp. Bur. Sci. Tech. Comm. No. 38. 1938–9.
5. **Glister, G. A.** Nature **148**: 470. 1941.
6. **Novogrudsky, D. M.** Adv. Biol. Sci. **5**: 509–536. 1936.
7. **Oxford, A. E. & Raistrick, H.** Chemistry and Industry **41**: 128–129. 1942.
8. **Porter, C. L. & Carter, J. C.** Bot. Rev. **4**: 165–182. 1938.
9. **Raistrick, H.** Jour. Soc. Chem. Ind. **16**: 293–294; Biochem. Jour. **32**: 687–696. 1938.
10. **Raistrick, H. & Smith, G.** Chem. & Ind. **60**: 828–830. 1941.
11. **Waksman, S. A.** Bact. Rev. **5**: 231–291. 1941.
12. **Waksman, S. A. & Woodruff, H. B.** Jour. Bact. **40**: 581–600. 1940.
13. **Waksman, S. A. & Woodruff, H. B.** Soil Sci. **50**: 421–427. 1940.
14. **Waksman, S. A. & Woodruff, H. B.** Jour. Bact. **43**: 9–10. 1942.
15. **Weindling, R.** Phytopath. **24**: 1153–1179. 1934.
16. **White, E. C. & Hill, J. H.** Jour. Bact. **43**: 12. 1942.

ZYGOSACCHAROMYCES ACIDIFACIENS: A NEW ACETIFYING YEAST

WALTER J. NICKERSON, JR.[1]

(WITH 4 FIGURES)

The organism to be described in this paper was isolated in the spring of 1938 from a bottle of domestic red wine turning sour. From wine souring to vinegar, one ordinarily expects to isolate bacteria belonging to the genus *Acetobacter;* however, careful examination both microscopically and by plating on nutrient agar failed to reveal members of this genus as present. On the contrary, a yeast was found in large numbers. So far as could be determined, the yeast was the sole occupant of the liquid in the bottle, thus confronting us with that very rare condition, namely, a pure culture in nature. This condition may have resulted, in part, from the high acidity of the wine for the pH was determined colorimetrically to be 2.2.

Single cell isolations of the organism were made using the Hansen technique; several isolates kept in culture for over a year showed the same properties and showed no variation in that time. The isolate kept in culture for the past four years, similarly, has shown no sectoring nor other variation.

The first attempts at identification of this yeast met with considerable difficulty. I tentatively considered the organism as belonging to the genus *Mycoderma* which includes imperfect yeasts, widespread in air, and frequently to be found in alcoholic solutions. They ordinarily form a scum on the surface of liquid media and rarely carry out an alcoholic fermentation, but are notorious for the production of acid from alcohol. *Mycoderma vini* (according to Lodder's 1934 classification) was the closest approach that could be made for this isolate but the position was actually untenable since no pellicle was ever formed by the yeast on any liquid medium and since the yeast did carry out an alcoholic fermentation.

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The situation regarding the taxonomy of this yeast was clarified by one of those fortunate accidents. A plate culture on nutrient-agar became contaminated with *Aspergillus niger* and examination of cells from this plate revealed many conjugating as iso-gametes and some conjugating pairs possessing spores with smooth walls. Such characteristics belong only to members of the genus *Zygosaccharomyces* since this is the only genus of budding yeasts to have conjugation of morphologically similar cells preceding the formation of spores with smooth walls. That the organism iso-lated was the organism seen conjugating (and not some other con-taminant) was established by going back to pure cultures of the isolated organism; by counting several hundred cells it was found that there was indeed a small percentage conjugation in older cultures.

The effect of *A. niger* in causing a high percentage of the yeast cells to conjugate and the general problem of the chemical control of conjugation in the genus *Zygosaccharomyces* has been investi-gated (Nickerson & Thimann, 1941, 1942). Briefly, it may be stated that there are two extractable substances elaborated by the growth of the mold; these substances, one of an acid nature, in combination, provoke extraordinary increases in the percentage of cells conjugating. The action of the two components has been duplicated with riboflavin (vitamin B_2) and glutaric acid.

The genus *Zygosaccharomyces* Barker belonging to the family Saccharomycetaceae is a large one numbering about 60 reported species. Since the genus has never been monographed, some of the species may no longer be valid, but it is clear nevertheless that caution is necessary before establishing a new species amidst such a large and varied assemblage as already exists. Therefore, it is only because of the unusual property of this yeast in making large amounts of acid (as the proposed specific name "acidifaciens" in-dicates), that I am proposing this as a new species.[2] I have checked its properties against descriptions of all the species (over 60) to be found in the literature, and none is similar to it. Dr. E. M. Mrak of the University of California has very kindly checked my obser-vations and agrees that it is apparently a new species.

[2] Cultures are being deposited with the American Type Culture Collection and with the Culture Collection of the Laboratory of Cryptogamic Botany, Harvard University.

MORPHOLOGICAL CHARACTERISTICS

Non-sexual phase.

Cells in malt extract broth (Difco) after 24 hours are ellipsoidal, 3–5 by 6–8 μ in size; mode of 100 counts was $4.3 \times 6.8 \mu$. After three days the dimensions and shape are still the same. The vegetative cells are always single or in pairs; there is no tendency to form budding chains nor towards mycelial formation in any medium used. On wort agar after three days, cell size and dimensions are the same as in malt extract broth; figure 1 *a* shows the appearance of cells from a 3 day culture on wort agar. In old cultures cells frequently elongate but do not form chains. Budding is chiefly terminal or slightly sub-terminal. It has been pointed out (Nickerson, 1942) that the bud of a yeast cell always arises so that its long axis is perpendicular to a tangent to the mother cell at the point of contact. The cells are vacuolated, colorless, and hyaline.

Ascosporic phase.

Production of ascospores in this species is preceded by conjugation of isogamous cells (FIG. 1 *b*). Usually only two spores are produced, one in each cell; however, four spores with two in each cell are occasionally seen. Sporulation occurs readily with the usual methods such as plaster blocks, Gorodkowa agar, etc., by the end of six days. The most favorable conditions for conjugation and resultant spore production are, however, on wort agar to which has been added a few cc. of the filtrate obtained from the growth of *Aspergillus niger* in malt extract broth. The ascospores formed are spherical, smooth, and 3–4.5 μ in diameter; the mode of counts on 100 spores was 3.5 μ.

Parthenogenesis is extremely rare in this species; a single cell possessing spores is practically never seen. While the conjugation has been called isogamous, an occasional case of anisogamy or conjugation between cells of noticeably different sizes has been observed; in this latter case, spores are formed only in the larger of the two cells. On staining water mounts of conjugating cells with methylene blue, it has been observed that in many cases (sometimes as high as 80 per cent of the conjugating pairs) one

of the cells of a pair takes up the stain while the other does not; a spore is generally present in each cell. This may possibly be an indication of physiological heterogamy. The production of more than one conjugation tube by a cell has occasionally been seen, as has the conjugation of one cell with two cells as a result of possessing more than one tube.

CULTURAL CHARACTERISTICS

In liquid culture, both in malt extract broth and in 10 per cent honey broth, there is no tendency towards formation of a pellicle, or of a yeast ring. The liquid remains clear during fermentation and CO_2 production is moderate.

Temperature limits for budding as determined by growth of slant cultures on agar are as follows: optimum, 26–28° C.; maximum 38–39° C.; minimum 4–5° C.

On a wort agar (Difco) streak, growth is good; both surface and margin are smooth with the growth spreading slightly. Lustre of the streak is dull and dry; the color is brownish-white; texture is soft and the form raised; no pseudo-mycelium is present. It is interesting that on wort agar of pH 4.7 the color is brownish-white (Ridgway, drab is the closest approximation), while on glucose-agar of pH 7.0 the color is cream-white (Ridgway, Tilleul-buff) and on glucose-chalk agar of pH 8.3 it is dead white (Ridgway, white).

The surface of the giant colony on 15 per cent honey agar is smooth with 2–3 lines radiating from the center (FIG. 2 a); this is a medium suggested by Lochhead (1929). On wort agar the surface of the young giant colony is somewhat punctate (FIG. 2 b) while a very old colony on the same medium shows the characteristic radiating lines, papillae, and a fringe of cells burrowing into the agar (FIG. 2 c).

A gelatin stab-culture shows no liquefaction even after three months; growth is best on top with no change in the medium.

PHYSIOLOGICAL CHARACTERISTICS

Glucose, fructose, and mannose are fermented strongly. The following are not fermented: galactose, sucrose, maltose, lactose, raffinose, arabinose, or dextrin. Growth with ethyl alcohol as the
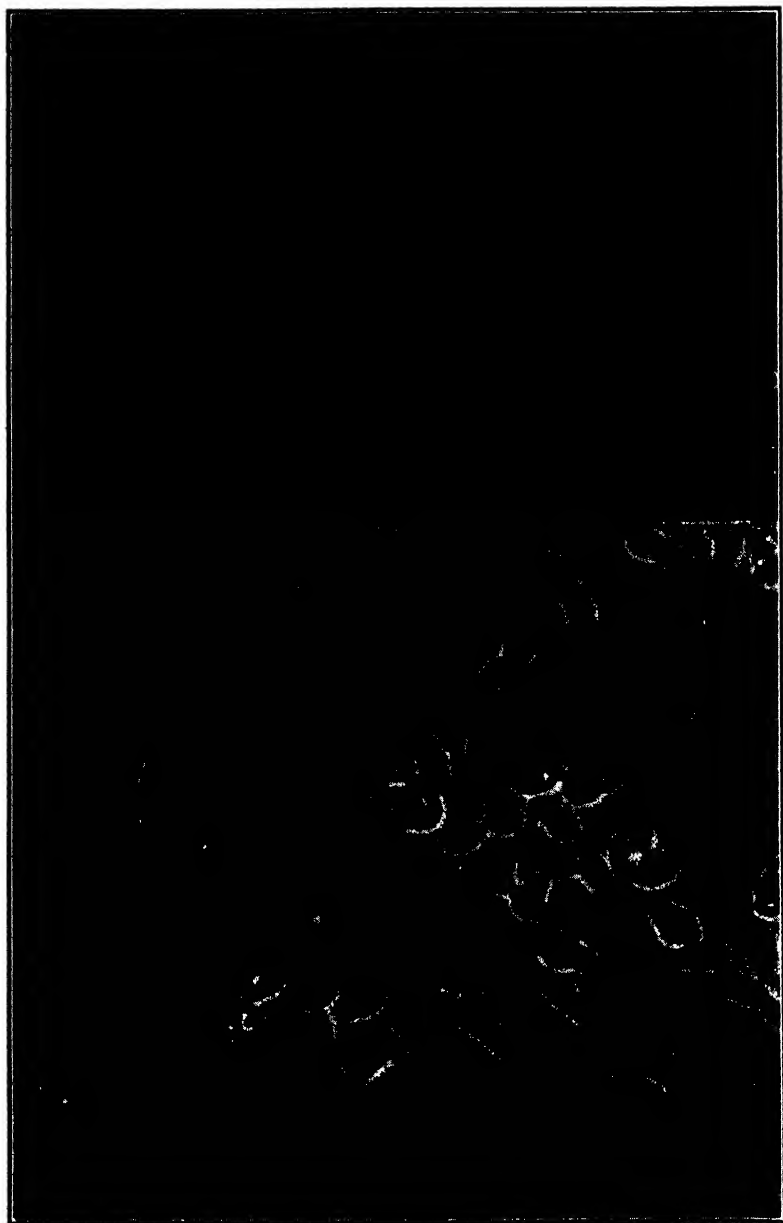
FIG. 1, above, vegetative cells of *Z. acidifaciens* from a 3 day culture on wort agar; below, conjugating cells of *Z. acidifaciens* with spores from a 9 day culture on wort agar treated with 5 mgm. glutaric acid and 100 micrograms riboflavin (total volume of plate culture 17 cc.).

sole source of carbon is light to moderate, no film being produced on the liquid. Growth with nitrate as the sole source of nitrogen (bios requirements[2] added with a trace of yeast extract) is moderate.

In respiration studies using the Warburg manometric technique it was found that the rate of oxygen consumption by this species was identical with glucose, ethanol, or acetic acid as substrate, but that fumarate, lactate, glutarate, and saccharic acid were not respired. The Q_{O_2} for glucose at 28° C. was 57, *i.e.*, 57 mm.[3] O_2 consumed per hour per mgm. dry weight of yeast.

The genus *Zygosaccharomyces* contains species exhibiting some of the most interesting properties. *Z. priorianus* Klöcker and *Z. rugosus* Lochhead & Farrell for example cause fermentation of 90 per cent glucose (a concentration of nearly 5 molar and one capable of producing an osmotic pressure of about 125 atmospheres!); *Z. guilliermondi* Dufrenoy grows in 28 per cent NaCl during the fermentation of citrons; Kroemer and Krumbholz (1932) have found some species capable of withstanding 40–50 per cent solutions of glycerin and saturated solutions of KNO_3. This species now adds production of 0.1 normal acid to the list.

Acid production.

This organism produces 0.10 normal total acid in a modified Williams' medium containing 30 per cent glucose. The composition of the medium is as follows:

* * * * * *

KH_2PO_4	2.0 gms.	Asparagine	1.50 gms.
$(NH_4)_2SO_4$	3.0 gms.	Glucose (variable)	20.0 gms.
$CaCl_2$	0.25 gm.	Bacto-peptone	2.0 gms.
$MgSO_4$	0.25 gm.	Yeast extract	0.10 gm.

Distilled water to make 1 liter

* * * * * *

Media containing various concentrations of glucose were inoculated and incubated for 15 days at 30° C. After this period the cultures were centrifuged and the clear supernatant liquid titrated with 0.10

[2] Dr. A. G. Lochhead, Central Experimental Farm, Ottawa, has very kindly determined that biotin and pantothenic acid are essential for this yeast, with thiamin overcoming an early lag in growth.
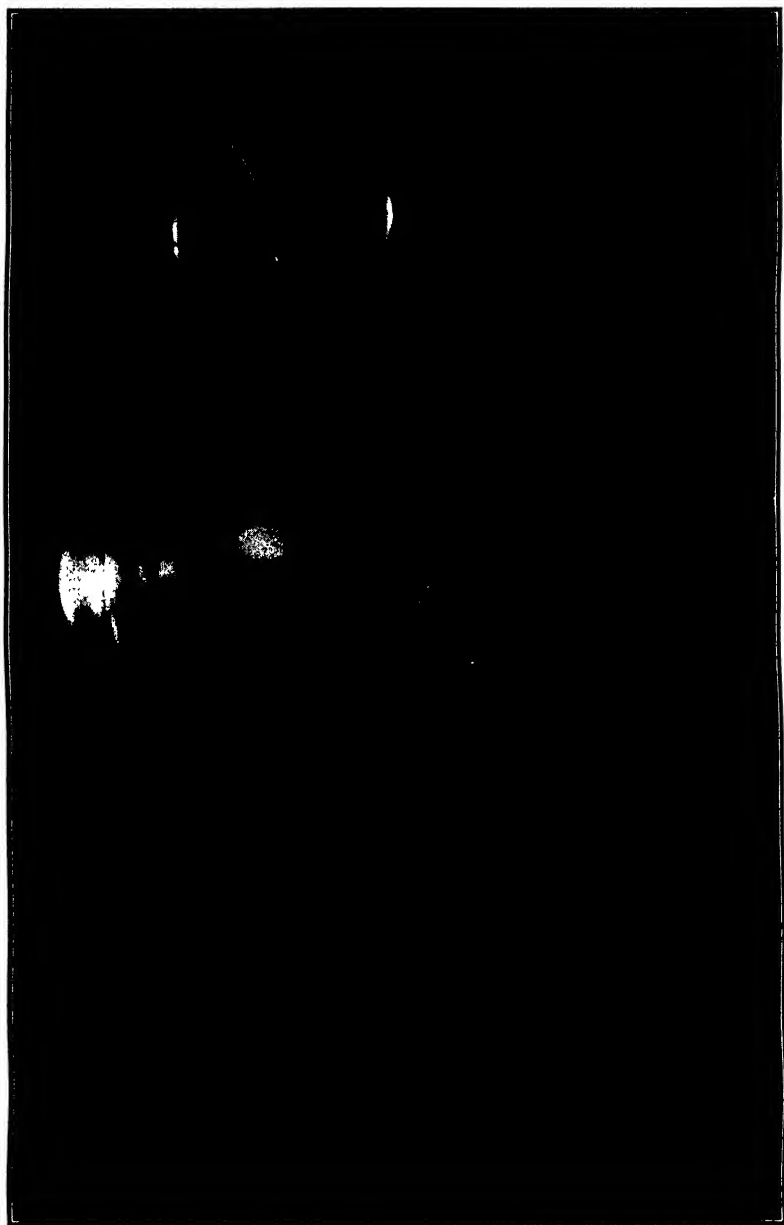
FIG. 2. Giant colonies of *Z. acidifaciens*. Above, 15 day colony on 15 per cent honey agar, actual diameter 15 mm.; center, 15 day colony on wort agar; actual diameter 20 mm.; below, very old colony, about 6 months, on wort agar, actual diameter 25 mm.

normal sodium hydroxide to determine the total acidity. Titration was to the first faint pink using 2 drops of 1 per cent phenolphthalein as indicator. The volatile acid was separated by steam

TABLE I

TOTAL ACID PRODUCTION WITH VARIOUS CONCENTRATIONS OF GLUCOSE;
STERILE MEDIUM TOTAL ACID 0.018 N, pH 5.8; VOLUME OF SOLUTION
300 CC. IN 500 CC. FLASKS

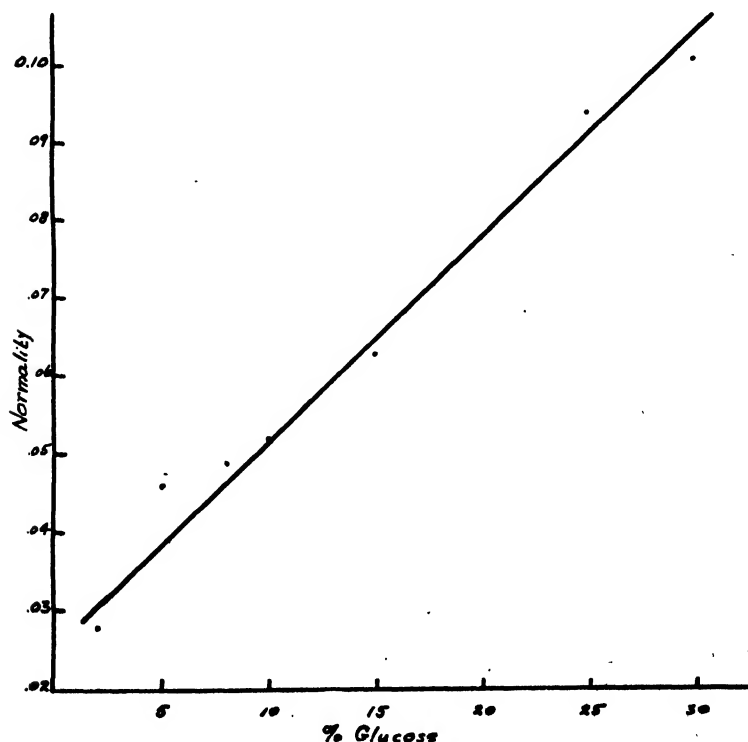| Per cent glucose	Total acid	pH
2	0.028 N	5.6
5	0.046	4.3
8	0.049	4.2
10	0.052	4.1
15	0.064	4.0
20	0.066	4.0
25	0.094	3.9
30	0.101	3.8

FIG. 3. Total acid production of *Z. acidifaciens* by fermentation of various concentrations of glucose in modified Williams' medium. Cultures 15 days old at time of sampling.

distillation and was found to comprise about 80 per cent of the total acid. Table I and figure 3 show the increase in total acid with increasing concentration of glucose. The volatile acid was found to consist almost entirely of acetic acid by means of the sharp melting point of the p-nitrobenzyl chloride derivative.

TABLE II

Total Acid Production with Various Concentrations of Ethanol Added to a Modified Williams' Medium Containing 2 Per Cent Glucose; Sterile Medium Total Acid 0.018 N, pH 5.8; Volume of Solution 300 cc. in 500 cc. Flasks

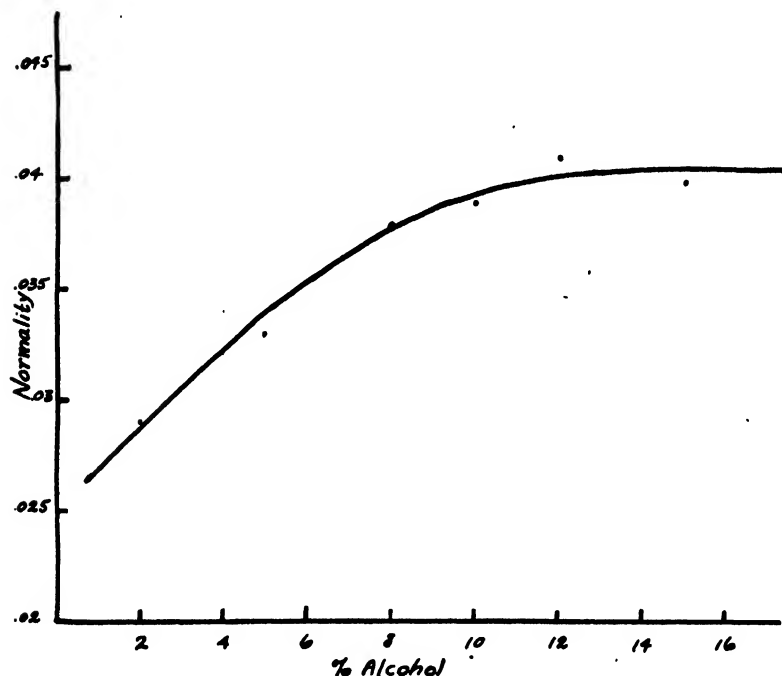| Per cent alcohol	Total acid	pH
2	0.029 N	5.1
5	0.033	4.9
8	0.039	4.2
10	0.040	4.1
12	0.041	4.1
15	0.040	4.1

Fig. 4. Total acid production of *Z. acidifaciens* with added ethanol. Alcohol expressed as final concentration after addition to a modified Williams' medium containing 2 per cent glucose. Cultures 15 days old at time of sampling.

An experiment similar to the above with added ethyl alcohol was performed. The total acid produced was found to be 0.04 normal at a concentration of 10 per cent ethanol; while growth was good up to 15 per cent alcohol, no higher amounts of acid were produced as is clear from table II and figure 4. Volatile acid was not determined in this case. With neither the sugar series nor the alcohol series did the pH of the cultures fall below 3.8; this was probably due to the buffering action of the phosphate in the medium. The pH was measured using a quinhydrone electrode for all cultures at the time of sampling for acid.

A useful diagnostic test for acid production by yeast is the glucose-chalk agar plate as employed by Custers (1940) in his work on the yeast-genus *Brettanomyces*. The test is conducted as follows:

A 5 per cent glucose-yeast extract agar with 0.5 per cent chalk (precipitated calcium carbonate) is autoclaved for 20 minutes at 15 pounds pressure; the agar is shaken well just before it hardens in a plate so as to disperse the chalk evenly. Plates are inoculated and incubated (preferably under both aerobic and anaerobic conditions) for 10 days at 25° C. Acid production is positive if nearly complete clearing of the agar occurs. A control plate inoculated with *Saccharomyces cerevisiae* should show little or no dissolution of the chalk.

With this test *Z. acidifaciens* shows some clearing aerobically but nearly complete clearing when grown anaerobically (in an evacuated desiccator over alkaline pyrogallol). More widespread incorporation of tests for acid production by yeasts into routine procedures might be of considerable use in the identification of this difficult group.

A more extended treatment of the physiology of this organism, including the phenomenon of acid production, will be presented elsewhere (Nickerson & Carroll, 1942).

RELATION TO OTHER MEMBERS OF THE GENUS

Since this species will cause a fermentation of a 60 per cent glucose solution, but not of an 80 per cent solution, and since it produces rather large amounts of both alcohol and volatile acids from fermentation of a 30 per cent sugar solution, it is inter-

mediate between the two types of yeasts in this genus as found by Kroemer and Krumbholz (1931). Their groups were as follows:

I. High sugar tolerance, little production of volatile acid, vigorous fermentation of a 90 per cent glucose solution with little alcohol produced.
II. Less tolerant to high osmotic pressure, producing some volatile acid and alcohol.

This organism is certainly not so tolerant of high osmotic pressures as are two species described by Lochhead and Heron (1929), *Z. Nussbaumeri* and *Z. Richteri*. *Z. acidifaciens* is rather an osmotoduric organism. The distinctions between tolerance of sugar concentrations and demand for high concentrations are not always sharp; they may lie in part in the previous history of the cells since adaptation to high sugar seems clearly possible. Dr. Lochhead (1941) suggests that temperature of incubation plays a part here. The author has chosen to use the words "osmotoduric" (withstanding, but not demanding, relatively concentrated solutions of sugar, salts, etc.) and "osmotophilic" in preference to the more customary term "osmophilic," since the former words express more clearly the root "osmotic." This species is similar to the following members of the genus in fermenting only glucose, fructose, and mannose, and having an isogamic conjugation preceding spore formation; it can be easily distinguished from these as noted, however.

1. *Z. Bailii:* forms long budding chains in young cultures; cells large and elongate, frequently amoeboid-shaped. Fermentation feeble and giant colony on wort agar slow growing and small. Does not grow with ethanol alone.

2. *Z. dairensis:* also forms long budding chains. Ferments raffinose weakly, and does not grow with ethanol as a sole source of carbon.

3. *Z. mellis:* forms a yeast ring in liquid culture, giant colony on honey agar is rough, with a notched edge, and a well defined concentric ring around the center. Vegetative cells nearly spherical 4.5–5 microns.

4. *Z. Richteri:* forms a yeast ring in liquid culture and liquefies gelatin in eight weeks. Tendency for cells to adhere together in clumps of various sizes.

Zygosaccharomyces acidifaciens sp. nov.

Young cells ellipsoidal (3–5×6–8μ), always single or in pairs, no budding chains; budding terminal or slightly sub-terminal. Optimum temperature for budding 26–28° C.; maximum 38–39° C.; minimum 4–5° C. No ring or pellicle formed in liquid media. Streak culture on wort agar brownish-white, texture soft, both margin and surface smooth; no pseudo-mycelium formed. Surface of giant colony on 15 per cent honey agar smooth with 2–3 lines radiating from center; on wort agar, the surface is somewhat punctate. Gelatin not liquefied after 3 months. Ascospores formed after an isogamic conjugation; usually one spore per ascus. Spore is spherical, smooth, average diameter 3.5μ. Parthenogenesis very rare. Fermentation of glucose, fructose, and mannose only. Growth with ethanol as sole source of carbon is positive (though light). Nitrate assimilation positive. Volatile acid production high from a sugar medium; will dissolve carbonate in glucose-chalk agar plates when grown anaerobically.

Cellulae parvulae ovoideae (3–5×6–8μ), semper singulae aut binae, gemmarum catenae nullae; gemmae extremo aut paene extremo. Calor optimus gemmandi 26–28° C.; calor maximus 39–39° C.; calor minimus 4–5° C. Fluentibus in mediis annulus membranaque non formantur. Cultura linearis in agaro maltato fusca-alba, textum molle, lēvis et margo et superficies; pseudomycelium abest. Superficies coloniae ingentis in agaro mellito 15% lēvis cum duo aut tres lineis radiantibus. In agaro maltato superficies non nihil puncta. Gelatinum non liquefitur. Ascospora isogamete post copulatione formantur; plerumque unum sporum quoque in asco. Sporum globosum lēveque ist, longitudo media lineae mediae 3.5μ. Parthenogenesis infrequens. Fermentatio glucosii, fructosii, mannosii, aliorum nullorum. Auctus parvus, quoad ethanol fons carbonis sola ist. Assimilatio nitratium adest. Aliquantum acidi fugientis de saccharonibus formatur. In agaro cerevisiae glucosato cum carbonato calcico in condicione anaerobia carbonatis calcicus liquefitur.

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LITERATURE CITED

1. **Custers, M. T. J.** 1940. Onderzoekingen over het gistgeslacht *Brettanomyces*. Thesis. Tech. Hoogeschool, Delft. trans. by H. J. Phaff and H. C. Douglas, Univ. Calif. Berkeley.

2. **Kroemer, K. & Krumbholz, G.** 1931. Untersuchungen über osmophile Sprosspilze I. Beiträge zur Kenntnis der Gärungsvorgänge und der Gärungserreger der Trockenbeerenauslesen. Archiv. Mikrobiol. **2**: 352–410.

3. ———. 1932. Untersuchungen über osmophile Sprosspilze V. Das Verhalten von Sprosspilze in Nährlösungen mit hohen Neutralsalzkonzentrationen. Archiv. Mikrobiol. **3**: 384–396.

4. **Lochhead, A. G. & Heron, D. A.** 1929. Microbiological studies of honey. Dom. Canada Dept. Agr. Bull. No. 116 n.s.

5. ———. 1941. Personal communication.

6. **Lodder, J.** 1934. Die Anaskosporogenen Hefen. Verhandl. Kon. Wetenschap. Amsterdam. **32**: 1–256.

7. **Nickerson, W. J. & Thimann, K. V.** 1941. The chemical control of conjugation in *Zygosaccharomyces*. Am. Jour. Bot. **28**: 617–621.

8. ———. 1942. The chemical control of conjugation in *Zygosaccharomyces* II. In preparation.

9. ———. 1942. Mechanics of budding and of conjugation in yeasts. Jour. Cell. Comp. Physiol. **19**: 379–382.

10. ——— **& Carroll, Wm. R.** 1942. The physiology of acid production by a yeast *Zygosaccharomyces acidifaciens*. In preparation.

11. **Ridgway, R.** Color standards and color nomenclature. 43 pp. Washington, D. C.

12. **Stelling-Dekker, N. M.** 1931. Die Hefesammlung des "Centraalbureau voor Schimmelcultures." I Teil. Die Sporogenen Hefen. Amsterdam.

THE OCCURRENCE OF AMPHISPORES IN THE LEAF RUST OF BLUEGRASSES [1]

John R. Hardison

(WITH 2 FIGURES)

Leaf rust of bluegrasses caused by *Puccinia Poae-sudeticae* (West.) Jorstad causes considerable reduction in forage and seed yields of economic species of *Poa* in northwestern United States. Fischer (2) reported the disease in epiphytotic form in Washington state. Sprague (5, 6) has also reported its occurrence in the Northwest, and the writer (3, 4) reported its development in Michigan.

During the summer of 1941 this species was found to be the only leaf rust occurring on bluegrasses in the writer's grass pathology nursery at the Botanical Garden of the University of Michigan. The fungus is readily recognized by the presence of abundant, capitate paraphyses in the uredia. This character assumes considerable taxonomic importance, since telia are rarely produced (1). In October, 1941 the uredia on plants of a single nursery row of *Poa pratensis* L. became dark brown in color, which was found to be due to the abundant development of amphispores in the uredia. Inasmuch as amphispores have not been previously reported for *P. Poae-sudeticae,* their morphology (FIG. 1) is here described in detail.

PUCCINIA POAE-SUDETICAE Emend.

Amphispores $19–23 \times 21–28 \mu$, the wall $1.7–2.6 \mu$, minutely echinulate, the pores 6, scattered, the pedicel generally persistent, colorless, once to twice the length of spore.

FIG. 1. Photomicrograph of *Puccinia Poae-sudeticae* showing amphispores and characteristic paraphyses, × about 200. (Photomicrograph by Dr. George W. Fischer.)

PURE CULTURE STUDIES

The amphispores would not germinate at maturity. A quantity of amphispores was placed outside October 29, 1941 in cheese cloth bags. On February 3, 1942 a two per cent germination was obtained and a 15–20 per cent germination on April 3. Germinating amphispores are shown in figure 2. Amphispores were sown on seedling plants resulting from seed of the same collection of *Poa pratensis* on which amphispores were collected. Uredia were produced seven days after inoculation, but no amphispores had developed 26 days after the inoculation. Urediospores which accompanied the amphisporic inoculum were non-viable. The uredia which developed from the inoculation with amphispores were characteristic in every respect for the species.. The abundant capitate paraphyses accompanying the urediospores provide unmistakable evidence of the connection of the amphispores in the life history of *P. Poae-sudeticae*.

Since amphispores were formed in uredia on only one collection of *Poa pratensis,* the question naturally arises as to what conditions brought about their production.   Other collections of this grass species in the same nursery were infected with uredia but were without amphispores.   A large number of specimens of the rust on *P. pratensis* was collected throughout Washtenaw County,
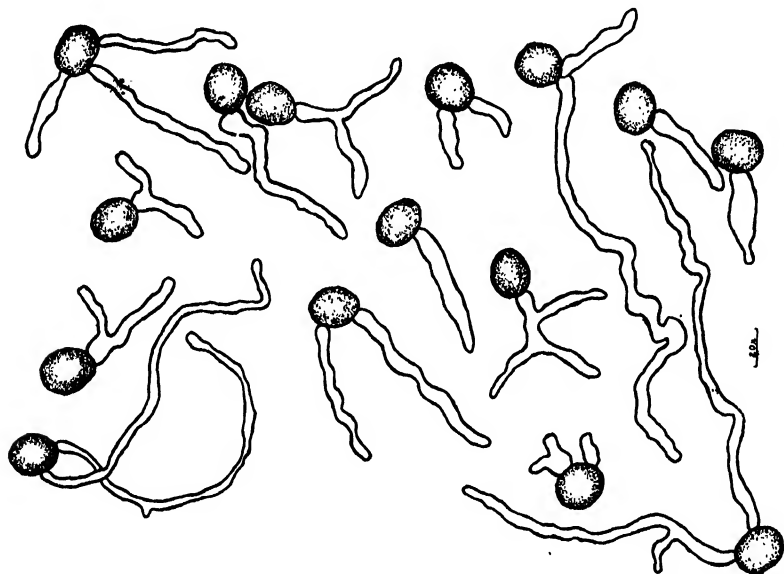
FIG. 2.   Germinating amphispores of *Puccinia Poae-sudeticae* after 24 hours on two per cent plain agar.

Michigan, likewise with only uredia.   The explanation of the appearance of amphispores remains a matter for conjecture, but it appears that their production must be related to the physiology of the host plant peculiar to the single grass collection.

Specimens have been deposited in the Mycological and Pathological collections of the Bureau of Plant Industry, Washington, D. C. and in the Herbarium of the University of Michigan.

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LITERATURE CITED

1. **Arthur, J. C.** Manual of the rusts in United States and Canada. 438 pages. Purdue Research Foundation. 1934.

2. **Fischer, George W.** Grass diseases in the Pacific Northwest in 1940. U. S. Dept. Agr. Bur. Plant Indus. Plant Disease Reporter **24**: 481–497. 1940.

3. **Hardison, John R.** Grass diseases in Michigan in 1940. U. S. Dept. Agr. Bur. Plant Indus. Plant Disease Reporter **25**: 120–125. 1941.

4. ———. Grass diseases in Michigan in 1941. U. S. Dept. Agr. Bur. Plant Indus. Plant Disease Reporter **26**: 67–75. 1942.

5. **Sprague, Roderick.** A revised check list of the parasitic fungi on cereals and other grasses in Oregon. U. S. Dept. Agr. Bur. Plant Indus. Plant Disease Reporter, Supplement 134. 1942.

6. ———. An annotated list of the parasitic fungi on cereals and other grasses in Klickitat County, Washington. U. S. Dept. Agr. Bur. Plant Indus. Plant Disease Reporter **26**: 228–240. 1942.

STUDIES IN SOME VENEZUELAN ASCO-MYCETES COLLECTED BY C. E. CHARDON AND A. S. MULLER

Julian H. Miller and M. Gwendolyn Burton

(with 10 figures)

Some of the recent collections of these mycological explorers have been found to be most interesting links in the phylogeny of the Ascomycetes. They have provided additional evidence for the hypothesis of the origin of the complexly organized Pyrenomycetes and Discomycetes in the higher Myriangiales.

Besides this discussion, the writers have made a few taxonomic changes, and reduced to synonymy some of Dr. Chardon's genera and species, and described one new species.

Dothiora subtropica (Wint.) comb. nov. (FIGS. 1–2)

> *Blitrydium subtropicum* Wint. Hedwigia 24: 263. 1885.
> *Tryblidaria subtropica* Rehm, Hedwigia 30: 252. 1891.
> *Blitrydium subtropicum* var. *microsperma* P. Henn. Hedwigia 41: 304. 1902.
> *Protoscypha pulla* H. Sydow, Ann. Myc. 23: 403. 1925.
> *Myrianginella costaricensis* Stev. Ill. Biol. Monog. 11: 165. 1927.
> *Protoscypha subtropica* Petrak, Ann. Myc. 32: 363. 1934.
> *Pittierodothis Miconiae* Chardon, Bol. Soc. Ven. Cien. Nat. 40: 14. 1939.

This fungus is a parasite on species of *Bagnisiopsis* occurring on living leaves of various Melastomaceae in the tropics. An infected *Bagnisiopsis* stroma can be distinguished by the pulverulent, tobacco-brown surface, in contrast to the more or less smooth black unbroken surface of one not so parasitized.

A longitudinal section of such a parasitized stroma (FIGS. 1–2), shows a parallel layer of asci each in separate locules, surrounded

by very small-celled pseudoparenchyma.   Below this one can often see the locules of the *Bagnisiopsis* with typical asci and spores. However, when a very young stroma becomes infected one is apt to think all of the tissue belongs to the *Dothiora*.   The blending of the host and parasite is so complete that there is no perceptible line between the mycelia of the two fungi.

The ascospores of *D. subtropica* are large, broadly elliptical, muriform with slight constrictions at the middle septa, hyaline, 18–33 × 8.5–13.5 μ; while those of the *Bagnisiopsis Toledoi* Chardon, in this study, are broadly elliptical, one-celled, hyaline becoming brown late, 7.6–16 × 7.6–11.4 μ.

The illustration in figure 1 is from a mature *B. Toledoi* stroma which shows locules of the latter in other sections.   The spiny projection at the left is typical of this *Bagnisiopsis* species.   Figure 2, on the other hand shows a *Bagnisiopsis* stroma which became infected at a very early period.

The striking resemblance to a Discomycete has resulted in its early position in genera of that group as shown in the above synonymy.   Sydow (10) under *Protoscypha pulla*, also considered it a Discomycete, but observed its relationship to the Myriangiaceae. He failed to note the *Bagnisiopsis* connection.   Later, however, he (11) recognized its parasitism and its identity with the Winter species, *subtropicum*, and with the Stevens species, *Myrianginella costaricensis*.

Petrak (6) cites the same synonymy and changes the name to *Protoscypha subtropica* and notes the *Bagnisiopsis* stroma.

Clements and Shear (2) place this fungus under *Protoscypha pulla*, in the Mollisiaceae with "apothecia folicole; epithecium present."   Then on another page they also place *Protoscypha pulla* as a synonym under *Dothiora* Fries in the Myriangiaceae. They did not mention the growth on the *Bagnisiopsis* stroma.

Chardon (1) made a new genus and species, *Pittierodothis Miconiae*, combining the stroma of the *Bagnisiopsis* in his description.   His flask-shaped locules apparently belong to *Bagnisiopsis*, but his spores are muriform, and so *D. subtropica*.

The type of *Dothiora* Fries is *D. pyrenophora* Fries, which equals *D. Sorbi* (Wahl.) Fuckel.   European specimens studied by the writers on *Sorbus aucuparia*, collected in Latvia, showed black
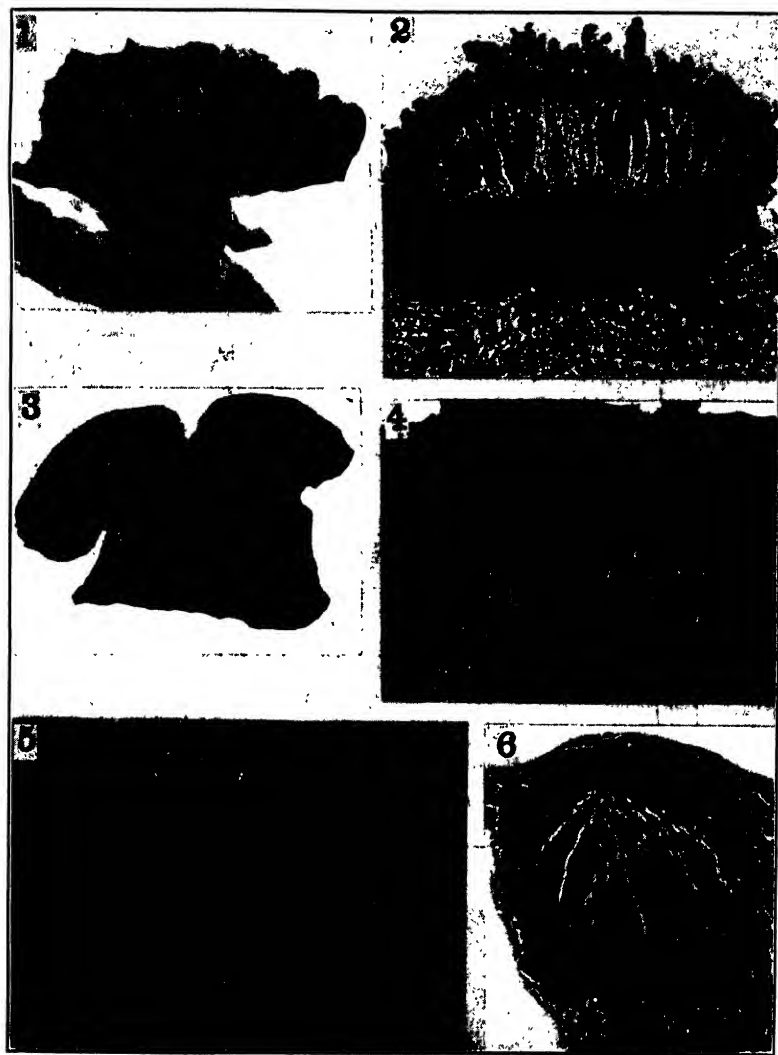
FIGS. 1–2, *Dothiora subtropica* growing in stroma of *Bagnisiopsis Toledoi*. Photomicrograph of longitudinal section. 1, × 60. 2, section showing asci embedded in pseudoparenchyma, × 178. FIGS. 3–5, *Auerswaldia examinans*. Photomicrograph of longitudinal sections. 3, showing entire stroma with peripheral ascal locules, × 24. 4, showing two fascicles of asci in locules, surrounded by stromal pseudoparenchyma, × 200. 5, young asci expanding upward to form cavity, × 200. FIG. 6, *Mycosphaerella venezuelensis*, photomicrograph of longitudinal section, showing a single fascicle of asci in a stroma and remnants of stroma in centrum, × 394.

partially erumpent stromata on branches. The asci were immature, but arranged in a palisade layer in pseudoparenchyma. These generic characters, along with the muriform spores, definitely place the species *subtropica* in *Dothiora,* and *Protoscypha* Sydow and *Pittierodothis* Chardon become synonyms of that genus.

Dothiora is placed in the Discomycetes by Saccardo (8) and also Lindau (5). On the other hand, Theissen and Sydow (15), in an appendix to the Dothideales, describe *Dothiora* as showing relationships to the latter order. They say each ascus lies in a special locule and the ascal layer has the appearance of a Discomycete. Later they (16) place the genus in the Myriangiales, family Dothioraceae. Gäumann and Dodge (3) also have it in this position. Clements and Shear (2) have it in both the Phacidiaceae and in the Myriangiaceae.

The genus *Dothiora* represents a high level of development in the Myriangiales order in which the asci are no longer scattered at different levels, but are drawn into one layer, and are not globose or semiglobose but are elongate. The chief single character distinguishing the entire group is the inclosure of each ascus in pseudoparenchyma, with the concurrent lack of filiform paraphysoids or paraphyses. At maturity there is a dissolution of the stromal tissue above the asci and each swells, independently elongating upward to the surface, to discharge the spores.

There is no very definite term to characterize this type of fruiting body. It cannot be called an apothecium nor perithecium, and while cleistothecium is expressive it must cover such widely diverse shapes as pulvinate irregular masses, or minute or large globose, or even plainly disc-shaped ascocarps.

Dothiora subtropica has been found on several different Melastomaceae hosts as well as *Bagnisiopsis* species. However, in most cases the latter have not been determined. Winter and Henning cited it from Brazil only on Melastomaceae leaves, while Sydow (10) has it on *Miconia Thomasiana* from Costa Rica, and later he (11) has the fungus on *Miconia ambigua,* on Melastomaceae undet., *Clidemia* sp., and *Clidemia plumosa,* all in Venezuela. These were on *Bagnisiopsis* spp. and on *Sucinaria minuta.* Chardon specimen No. *2666* also from Venezuela is on *Miconia dodecandra* on *Bagnisiopsis Toledoi* and Nos. *3110* and *3749* are on

Miconia sp.   The last is parasitizing *B. Toledoi.*   The genus *Sucinaria,* mentioned above is a synonym of *Bagnisiopsis.*

AUERSWALDIA EXAMINANS (Mont. & Berk.) Sacc. Syll. Fung. 2:
626.   1883.   (FIGS. 3–5)

Sphaeria examinans Mont. & Berk. Hook. Lond. Jour. Bot. 1:
156.   1842.
Dothidea examinans Mont. & Berk. Lond. Jour. Bot. 3: 520.
1844.
Auerswaldiella disciformis Chardon, Bol. Soc. Ven. Cien. Nat.
40: 11.   1939.

This species, anatomically, is a typical member of the Dothideales in the sense of the Friesian genus *Dothidea,* with its type *D. Sambuci* Pers. ex Fries. *Auerswaldia* differs from *Dothidea* chiefly in the possession of continuous instead of one-septate spores. The asci arise from convex masses of fertile hyphae, more or less evenly spaced in the periphery of the stroma (FIG. 3). In developing they expand vertically, producing a dissolution of the surrounding stromal elements (FIGS. 4–5). This creates a locule containing a fascicle of many asci inclosed by no differentiated wall, but only stromal pseudoparenchyma. There are no filaments between the mature asci in any one locule.

The locule pore is not a true ostiole in the sense of the one formed in the Sphaeriales. The tissue directly above the cavity, as shown in figure 5, is composed of very fine deeply staining pseudoparenchyma, contrasting rather sharply with the surrounding larger elements. This disintegrates as the asci mature, leaving an opening to the surface, which is not bordered by a specialized wall.

The type of *Auerswaldia examinans* was collected in Java. Later Rehm (7) described it from the Philippines and now Chardon and Muller have found specimens, Nos. *2411, 2556, 2404, 3295,* in Venezuela. No host has been cited in any case, only its occurrence on dead wood.

The Chardon specimens have been compared with part of the Montagne and Berkeley type in the Harvard herbarium. The latter shows the same dothideaceous locules and one-celled brown

ascospores, 15–22.8 × 9–11 μ. With a faint light, longitudinal striations were observed in the spore walls of both the type and those from Venezuela. This character has apparently been overlooked in previous descriptions.

Chardon thought there were paraphyses between the asci which accounts for his inclusion of the fungus in *Auerswaldiella*.

Auerswaldia examinans differs from *D. subtropica* in possessing a fascicle of asci in each cavity, instead of the single ascal locules, and in having one common pore for a group of asci to discharge their spores through, rather than each ascus attaining the surface through a separate opening. These constitute the chief differences between the Myriangiales and Dothideales concepts. Neither have specialized walls surrounding groups of asci nor filamentous threads in the centrum. The Dothideales could have arisen from the Myriangiales by the simple proliferation of the hypha producing the single ascus to form a fascicle.

Mycosphaerella venezuelensis sp. nov. (FIG. 6)

Maculae amphigenae, irregulariter orbicularae, pallide brunneae, centra interdum resolventia et cadentia, .5–3 cm. in diam., in vivis foliis; perithecia sparsa, epiphylla, minuta, globosa vel depresso-globosa, 75–100 μ in diam., atro-brunnea, in mesophyllo immersa, partietibus carbonaceis, 10–20 μ crassis, pseudoparenchymatis, ostiolo punctiformo; asci fasciculati, ex basi perithecii evoluti, cylindraceo-clavati, membrano .6–1.5 μ crasso, breviter stipitati, 45–50 × 11–12 μ; ascosporae 8, biseriatae, vel inordinatae, hyalinae, fusoido-ellipticae, utrinque obtusae, constrictae, 1-septatae, 16–19 × 4–6 μ; paraphyses nullae.

Spots amphigenous, irregularly orbicular, pale brown, centers breaking up and falling out, .5–3 cm. in diam., in living leaves; perithecia sparse, epiphyllous, minute, globose or depressed-globose, 75–100 μ in diam., dark brown, immersed in the mesophyll, with carbonous walls, 10–20 μ thick, pseudoparenchymatous, with punctiform ostiole; asci fasciculate, arising from the base of the perithecium, cylindric-clavate, with walls .6–1.5 μ thick, briefly stalked, 45–50 × 11–12 μ; ascospores 8, biseriate or inordinate, hyaline, fusoid-elliptic, with slightly obtuse ends, constricted, 1-septate, 16–19 × 4–6 μ; no paraphyses.

On living leaves of *Canavalia ensiformis,* Caracas, Venezuela, Muller No. *2368,* in Cornell Herbarium.

This fungus differs from the Philippine *Mycosphaerella Canavaliae* Sydow, in possession of larger spores. Sydow (**9**) gives those of the latter as 13–15 × 2–3 μ.

The genus *Mycosphaerella* as shown in figure 6 has all of the centrum characters of the locule of *Auerswaldia* (FIGS. 4–5). There are no paraphyses nor paraphysoids, only cellular remnants due to the dissolution and compression effects of expanding asci. *Mycosphaerella* then is apparently the high point in a developmental series beginning in the higher Myriangiales, and continuing through the compound Dothideales to the single stromal locules. We start with many locules, but only one ascus in each in *Dothiora,* then go to many locules, but several to many asci in a fascicle in each in *Auerswaldia,* and end the series with perithecial-like stromata containing only one locule with a more constant and compact fascicle in *Mycosphaerella.*

Epiphyma nervisequens (Chardon) comb. nov. (FIG. 7)

> *Dimeriellina nervisequens* Chardon, Bol. Soc. Ven. Cien. Nat. **40**: 5. 1939.

This fungus is a parasite on leaves of *Lantana camara* in Venezuela. The ascocarps appear to the eye as single, superficial perithecia, in rows following the veins on the upper side of the leaves. Figure 7 is a picture of a longitudinal section of No. *2611,* the Chardon type. This shows plainly that the so-called perithecia are locules in an elongate stroma with only the upper part of the locule wall partially free. The stroma may contain single locules or many in a row. The separations between locules are entirely stromatic as in the Dothideales. The stromata are not completely free on the surface, but extend into a hypostroma in the upper mesophyll. There are filiform threads, or paraphysoids between the asci, connected above and below. The ascospores are one-celled, hyaline, elliptical, 19–25 × 7–9.5 μ.

The genus *Epiphyma* is based on *E. anceps* (Höhnel) Theissen, or *Botryosphaeria anceps* Höhnel. The writers were not able to obtain a specimen of the type to study. The description and illustration by Theissen (**12**) consists of free perithecial-like stromata on thin twigs, with no true ostiole, with asci surrounded by no

genuine paraphyses, but threadlike plectenchyma, with one celled hyaline ascospores. Later, he (13) says *Epiphyma* is a *Parodiella* with colorless, one-celled spores. Then in his (14) introduction to the Pseudosphaeriales he places it in that order and in the family Parodiellaceae.

Clements and Shear (2) have *Epiphyma* in the Sphaeriaceae—hyalosporae, with—"perithecia superificial from the first, not beaked, glabrous, and paraphysoids present."

Chardon (1) erected the genus *Dimeriellina* for this single species with approximately the same characters as given by Theissen, or Clements and Shear, for *Epiphyma*. However, he called the interthecial threads paraphyses instead of paraphysoids, and then he places his genus in the Perisporiales. The type is No. *2611* collected by Chardon and Barnes. Chardon cites another specimen, Muller No. *1941,* not studied by the writers.

Theissen and Sydow (16) separate the Perisporiales by closed Ascomycetes with globose perithecia without ostioles, which contain a free fascicle of asci arising from the base. Clements and Shear (2) distinguish the order on perithecia with ostiole and paraphyses usually lacking. *Dimeriellina* then with its paraphysoids and asci not in a fascicle cannot remain in the Perisporiales, but falls in the Pseudosphaeriales as a synonym of *Epiphyma* along with such genera as *Parodiella* and *Apiosporina*.

There is a species of *Epiphyma, E. neurophilum* Theiss. whose description nts the Chardon specimen very well, but it is on *Tibouchina* sp. from Colombia. This was not in the Theissen herbarium at Harvard, and so could not be studied. However, this may be a different species as the hosts are not the same.

Hypospila Oyedaeae (Sydow) comb. nov. (FIG. 8)

Phyllocelis Oyedacae Sydow Ann. Myc. 23: 353. 1925.
Phomatospora Oyedaeae Chardon, Bol. Soc. Ven. Cien. Nat. 40: 27. 1939.

The perithecia, usually separate, occasionally two or more together, are sunken in the mesophyll of the leaf, with true pseudo-prosenchymatous walls, with a short broadly-papillate ostiole erumpent through a clypeus in the lower epidermis. The centrum

consists of a wall layer of asci interspersed with band-like para-
physes with free apices.   At maturity the asci separate from their
attachment, and the paraphyses gelatinize and disappear, leaving
the cavity filled with free asci.   The spores are spindle-form, fu-
soid, straight to slightly curved, 2–4 septate, hyaline, 18–32 ×
6–8 μ.

There is a conidial stage in the Chardon specimens directly over
each perithecium.   This has apparently not been adequately de-
scribed, although Chardon noted the presence of conidia and gave
measurements.   The writers did not see the Sydow specimen, but
his description for the perithecial form fits the Chardon fungus
exactly, and so it is logical to think he must have had the acervuli
on his leaves.   In every case sectioned there are acervuli opening
on the upper side, and perithecial ostioles erumpent through the
lower epidermis.

Conidial stage: Acervuli in spots developing under the upper
epidermis, 200–300 μ in diam., orbicular to irregular, opening by
large pore; conidiophores in palisade layer, with conidia filiform,
curved, hyaline, 15–25 × .5–1 μ.

The connection between the acervulus and the perithecium has
not been established by inoculations, but the relationship seems
obvious as the two are together in every spot.

On *Oyedaea verbesinoides*.   The Sydow type is from Costa
Rica, while the Chardon collections, Nos. *2509, 2526, 2716, 2874,*
are from Venezuela.

Sydow created the genus *Phyllocelis* for this fungus and charac-
terized it as diaporthoid.   The characters of true perithecia with
asci that float out in masses in water are typical of the family
Diaporthaceae.   Chardon evidently failed to note this fact, and
also that the ascospores are septate, and so he places the species in
Phomatospora, describing it as new.

Clements and Shear (2) have *Phyllocelis* in the Hypocreaceae
hyalophragmiae, with "perithecia in a stroma, not compound, os-
tiole broad-conic erumpent; folicole."   There is very little fungous
tissue outside of the perithecium that could be called a stroma and
the clypeus is not very well developed.   The fungus does not
appear colored to the writers, so it could hardly fall in the
Hypocreaceae.
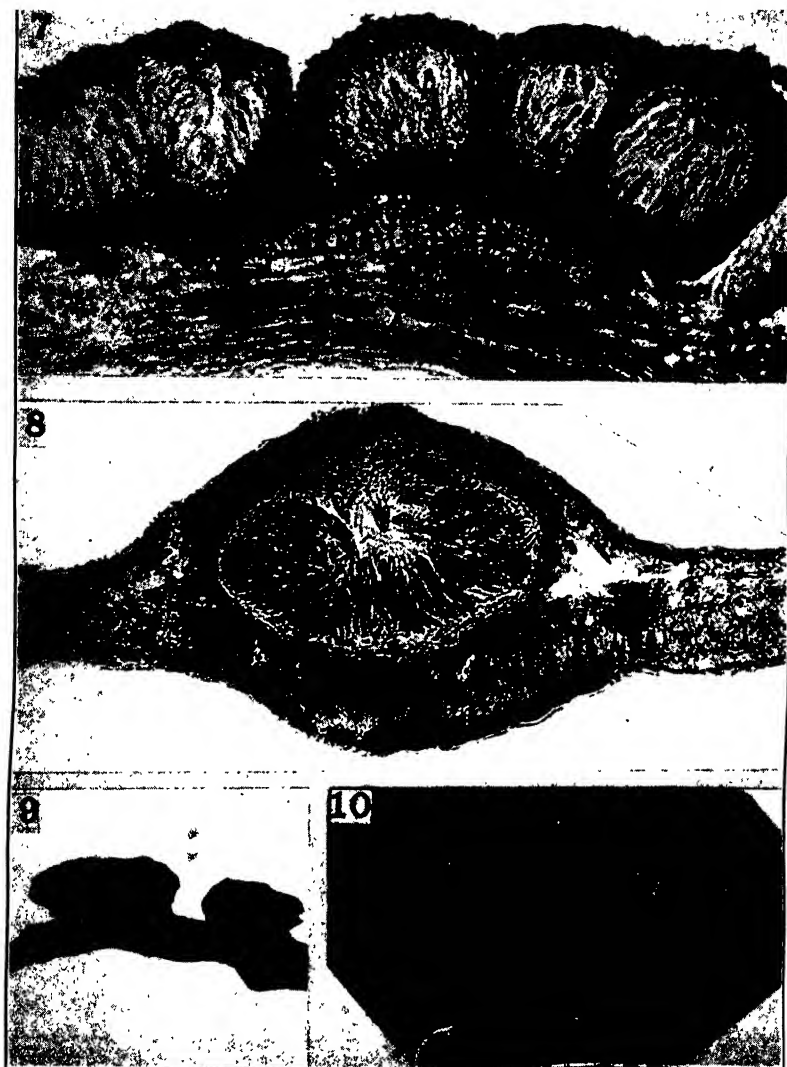
FIG. 7, *Ephiphyma nervisequens*. Photomicrograph of longitudinal section showing several locules in each stroma with hypostroma in leaf, × 94. FIG. 8, *Hypospila Oyedaeae*. Photomicrograph of longitudinal section, showing distinct wall to perithecium inclosing diaporthoid asci and paraphyses; and the conidial stage, acervulus, opening on the lower surface, × 150. FIGS. 9–10, *Mollisia Grisleae*. Photomicrograph of longitudinal sections. 9, showing two entire apothecia, × 75. 10, part of apothecium enlarged, showing asci embedded in paraphyses and the dark pseudoparenchymatous exciple, × 338.

The genus *Hypospila* Fries is based on *H. pustula* (Pers. ex Fries) Karst. according to Clements and Shear (2). They place this genus in the Sphaeriaceae-hyalophragmiae, with "perithecia innate, with clypeus, not beaked, and paraphyses lacking."

Von Höhnel (4) finds *Sphaeria pustula* Pers. is not the type of *Hypospila* Fries, and creates a new genus for it—*Chalcosphaeria*. His conception of the latter is, perithecial nucleus diaporthoid, with hyaline, spindleform spores chiefly 2-celled, but occasionally 3–4-celled, on leaves. It seems best in cases like this to arbitrarily pick a species for the type that is in line with the current concept of the genus, rather than go back and dig up the first described species which would result in much present confusion. In following Clements and Shear then in adopting *S. pustula* for the type the concept of *Hypospila* remains the same as for the last 70 years. The characters of *Phyllocelis* are identical with this characterization of *Hypospila,* and it is reduced to synonymy.

Hypospila Oycdacac represents a high level of development in the Ascomycetes. With its diaporthoid centrum inclosed by a special wall it is quite distinct from the Pseudosphaeriales form, *Epiphyma nerviscquens,* or the Dothideales branch with the examples of *Aucrswaldia examinans* and *Mycosphaerella venezuelensis.* Both groups must have developed from the more primitive Myriangiales.

Mollisia Grisleae (Sydow) comb. nov. (FIGS. 9–10)

Antimanoa Grisleae Sydow, Ann. Myc. **28**: 170. 1930.

This minute leaf parasite forms discs on the upper surface, 150 to 300 μ in diam. When wet they expand showing a concave to flat surface with thick-walled pseudoparenchymatous dark exciple. The ascospores are one-celled, hyaline, elliptical, 13–17 × 5–7 μ. The paraphyses are filiform and slightly branched. Figure 10 shows the large-celled exciple and hypothecium resting on the leaf epidermis.

Both the Sydow and Muller (No. *1942*) collections are from Venezuela on leaves of *Grislea secunda.*

Sydow created the genus *Antimanoa* for this species, and says it has plain Hemisphaeriales relationships, and also corresponds to a superficial Phacidiaceae.   When dry and shriveled the apothecia do become flattened-hemispherically in a manner suggesting the former order, but when wet they expand into a typical *Mollisia*, with disc with even border and dark exciple.

If the *Dothiora* in figure 2 is compared with that of this *Mollisia* in figures 9 or 10 a striking resemblance is to be seen.   The chief difference lies in the cellular interascal tissue in the former and free filiform threads in the latter.   The basal tissue is dark pseudo-parenchymatous in both cases.   Such Discomycetes could have arisen from the higher Myriangiales by the development of threads between the asci to replace the cellular interthecial tissues.

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LITERATURE CITED

1. **Chardon, C. E.** Adiciones a la Flora Micologica de Venezuela.   Bol. Soc. Ven. Cien. Nat. **40**: 1–34.   1939.
2. **Clements, F. E. & Shear, C. L.** The genera of fungi.   496 pp.   The H. W. Wilson Co., New York.   1931.
3. **Gaümann, E. A. & Dodge, C. W.** Comparative morphology of fungi.   701 pp.   McGraw-Hill Book Co., New York.   1928.
4. **Höhnel, F. von.** Mycologische Fragmente 231.   Ann. Myc. **16**: 97.   1918.
5. **Lindau, G.** E & P.   Naturlichen Pfl. 1¹: 256.   1897.
6. **Petrak, F.** Mykologische Notizen.   XII.   Ann. Myc. **32**: 317–447.   1934.
7. **Rehm, H.** Leaflets Phil. Bot. **6**: 2274.   1914.
8. **Saccardo, P. A.** Syll. Fung. **8**: 764.   1889.
9. **Sydow, H.** Ein neuer Beitrag zur Kenntnis der Pilzflora du Philippinen Inseln.   Ann. Myc. **21**: 100.   1923.
10. ———.   Fungi in Itinere costaricensi collecti.   Part 1.   Ann. Myc. **23**: 308–429.   1925.
11. ———.   Fungi venezuelani.   Ann. Myc. **28**: 29–224.   1930.
12. **Theissen, F.** Studie über *Botryosphaeria*.   Ann. Myc. **14**: 297–340.   1916.
13. ———.   Beiträge zur Systematik der Ascomyzeten.   Ann. Myc. **14**: 401–439.   1916.
14. ———.   Vorentwürfe zu den Pseudophaeriales.   Ann. Myc. **16**: 1–34.   1918.
15. **Theissen, F. & Sydow, H.** Die Dothideales.   Ann. Myc. **13**: 149–746.   1915.
16. ———.   Synoptische Tafeln.   Ann. Myc. **15**: 389–491.   1917.

A DASYSCYPHA FOLLOWING CRONAR-
TIUM RIBICOLA ON PINUS
MONTICOLA.[1] I

RICHARD T. BINGHAM [2] AND JOHN EHRLICH [3]

(WITH 2 FIGURES)

During the course of a study on secondary fungi associated with
blister rust cankers of *Pinus monticola* Dougl. a *Dasyscypha* of
uncertain identity was frequently encountered.   This fungus had
in the past been variously designated as *D. Agassizii* (Berk. &
Curt.) Sacc. and *D. calyciformis* (Willd. ex Fries) Rehm, appar-
ently with some question as to its identity.   In view of the con-
fusion which has existed between these fungi, all three have been
studied.

DASYSCYPHA CALYCIFORMIS

Late in the eighteenth century, Willdenow (**1787**: 404) de-
scribed a fungus which he called *Peziza calyciformis* and, without
mentioning any host, reported that it occurred on tree trunks and
on rotting twigs on the ground ("In arborum truncis, ramulisve
dejectis putrescentibus").   He gave neither ascospore measure-
ments nor other means by which this fungus might be recognized
today.   Willdenow based his description on Batsch (**1786**: 195),
who was preceded in the use of the specific epithet *calyciformis*
(according to Plassmann (**1927**: 8)) by Gleditsch (**1753**), who, in
turn, cited Dillenius (**1719**: 195) as the presumed author of the
epithet.

Later, however, in the Systema, Fries (**1822**: 91–92) described
three forms of a fungus which he called *P. calycina,* the first of

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which, "α. *Pini silvestris*," he reported as synonymous with *P. calyciformis* Willd. and *P. calycina* Schum.[4]   In so doing Fries lowered the fungus under consideration to varietal status.   Finally Rehm (**1893**: 834–835) again raised this fungus to specific rank and applied to it the epithet *calyciformis* of Willdenow, which Fries had recognized in the Systema.   Since *calyciformis* is the first legally published epithet for this species, Rehm thus acted in conformity with the International Rules (Briquet **1935**: Art. 58). At the same time Rehm transferred the fungus to the genus *Dasyscypha* and published the new combination *D. calyciformis*. According to Recommendation XXXII, the species should, therefore, be cited as *Dasyscypha calyciformis* (Willd. ex Fries) Rehm.[5]

Opportunity has been afforded for the examination of an authentic Rehm exsiccatus (Ascomyceten *1163*), issued in 1896 under the name of *D. calyciformis* Willd.   This exsiccatus was acquired by the New York Botanical Garden Herbarium (NY.[6]) as a part of the Ellis Collection and was made available for study through the courtesy of Dr. Seaver.   Several well preserved apothecia are present, the morphological details of the perfect stage agreeing closely with those in Rehm's description.

[4] Fries probably confused two distinct species, for Schumacher (**1803**: 424) (according to Hahn and Ayers (**1934**: 76)) had described his Discomycete as occurring on cones of (?) *Picea abies* Karst. ("in strobylo *Pini abietis*"). It seems unlikely that Schumacher's fungus on spruce cones was the same as Willdenow's fungus on trunks and twigs, especially since none of the specimens or reports examined in the course of the present study show Willdenow's fungus to occur on any substratum other than the bark of *Abies, Picea,* or *Pinus*.   On the other hand, it is not unlikely that Fries may have been correct in his belief that Willdenow's *P. calyciformis* was synonymous with his own *P. calycina* α. *Pini silvestris* since *D. calyciformis* presumably does occur on bark of *Pinus sylvestris* L.   In any event, Fries recognized and published the epithet *calyciformis* of Willdenow.

[5] Since Hahn & Ayers (**1934**: 77) have shown that the name *D. calycina* should be reserved for a large-spored species of Fuckel (**1869/70**: 305), Plassmann's (**1927**: 8–9) use of this name for *D. calyciformis* is regarded as untenable.

[6] Herbarium abbreviations follow Lanjouw (**1939**).

FIG. 1. *Dasyscypha calyciformis* (Willd. ex Fries) Rehm. Drawings made with aid of a micro-projector; those of the perfect stage from Rehm: Ascomyceten *1163*, those of the imperfect stage from Kryptogamae Exsiccatae *1821*. *A*, asci and ascospores; *B*, ascospores; *C*, excipular hairs; *D*, conidiophores and phialides; *E*, conidia.
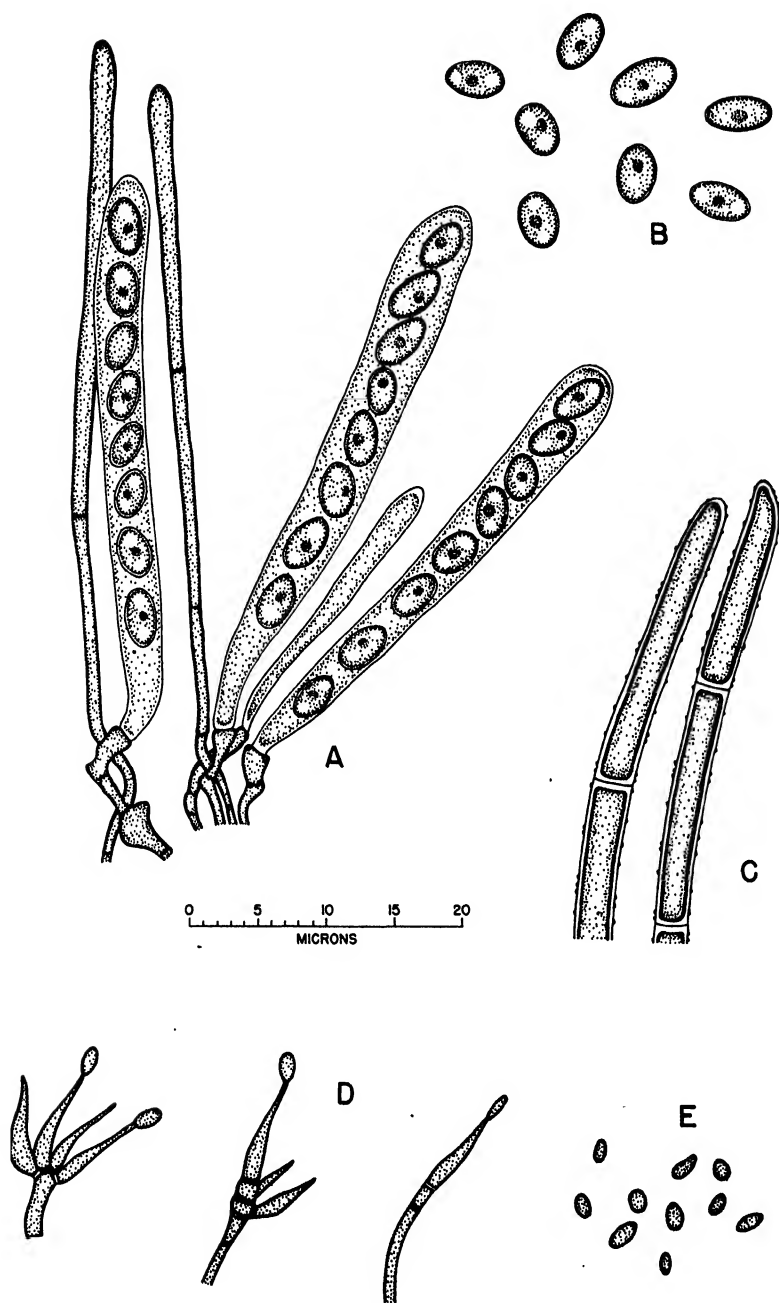
Fig. 1

An amended description of *D. calyciformis* follows, using this
exsiccatus as its base.   It is recognized that this description is
inadequate because it was not possible to study the fungus in
culture or to examine fresh European material on various hosts.
Only a limited number of dried specimens, not including any types,
were available.   It is intended that this description will, neverthe-
less, serve to distinguish this species from the fungus on *Pinus
monticola*.

DASYSCYPHA CALYCIFORMIS (Willd. ex Fries) Rehm in Rab.
     Krypt.-Fl. 1 (3): 834–835.   1893.
     Elvella calyciformis Batsch, Elench. Fung., Cont. 1: 195.   1786.
     —Teste Hiley, Fungal diseases of the common larch: 76.
     1919.
     Peziza calyciformis Willd., Fl. Berol. Prodr.: 404.   1787.—
     Teste Fries, Syst. Myc. 2: 91.   1822; Rehm, *loc. cit.*
     Octospora calyciformis Hedw., Descr. Musc. Frond. 2: 64.
     1789.—Teste Rehm, *loc. cit.*
     Peziza calycina α. *Pini silvestris* Fries, Syst. Myc. 2: 91.   1822.
     (?) *Dasyscypha calycina* (Schum.) Fuckel, Symb. Myc. 305.
     1869/70.—Teste Oudemans, Enum. Syst. Fung. 1: 367.
     1919.   Cf. Hahn in Mycologia 26: 76–77.   1934.
     Helotium calycinum Karst., Myc. Fenn. 1: 154.   1871.—Teste
     Rehm, *loc. cit.*
     (?) *Dasyscypha bruyeriensis* (Roum.) Sacc. in Michelia 2: 330.
     1881.—Teste Rehm, *loc. cit.* Sed. syn. *D. subtilissima*
     (Cooke) Sacc., Syll. Fung. 8: 438.   1889;—teste Sacc., *loc.
     cit.*
     Lachnella calycina Karst., Rev. Monogr. Ascom. 2: 131.   1885.
     —Teste Rehm, *loc. cit.*
     Erinella calycina Quél., Enchir. Fung. Europa: 303.   1886.—
     Teste Rehm, *loc. cit.*
     Helotium calyciforme Wettstein in Bot. Centralbl. 31: 285.
     1887.—Teste Rehm, *loc. cit.*
     Dasyscypha calycina Fries sensu Plassmann, Untersuchungen
     über den Lärchenkrebs: 8–9.   1927.

Apothecia abundant, sub-phellar or shallowly intraphellodermal,
erumpent, gregarious or solitary, occasionally joined at the base on

a subicle; *stipes* short but distinct, each with one to several cups; *cups* when young globular, closed, with age opening circularly and expanding under moist conditions to a cup-like or saucer-like form, margins at maturity moderately thin, externally whitish with excipular hairs; *hairs* long, unbranched, cylindrical, moderately to considerably roughened by minute tubercles, the tips usually subacute, occasionally rounded, extremities ordinarily unswollen, noticeably septate at intervals of 10 to 25 μ, 2.5–4.0 μ broad, persistent except in the oldest and most weathered specimens (FIG. 1, *C*); *discs* orange to orange-yellow, small, 0.5–2.0 mm. broad; *hyphae* of the context variable in width, 2.0–5.0 μ broad, septate, profusely branched. **Asci** cylindrical to cylindric-clavate, with rounded apices; size range (90) 36.0–58.5 × 4.0–6.0 μ, commonly 43–54 × 4.5–5.5 μ (FIG. 1, *A*). **Ascospores** eight; *arrangement* uniseriate, oblique with the basal spores vertical, occasionally irregular or biseriate; enclosing *membrane* rounded at the apex, following the contour of the ascus wall; *shape* elliptical to plump-ovate, occasionally with one end (the lower when in the ascus) slightly more acute or, in older and more weathered specimens, collapsed making the shape irregular; *walls* thin; *contents* hyaline, indistinctly nucleate and biguttulate, continuous while in the ascus (germination not observed); *size* range (165) 4.0–7.5 × 1.5–3.5 μ, commonly 4.5–7.0 × 2.0–3.0 μ (FIG. 1, *A & B*). **Paraphyses** usually exceeding the asci by from 5 to 10 μ, relatively sparse, relatively coarse and stout for their length, occasionally very minutely roughened, branching not seen; *shape* cylindrical or tapering slightly and evenly to the base, tips rounded or sub-acute with obtuse extremities; *contents* hyaline, obscurely septate, minutely guttulate; *size* range (70) 45.0–77.0 × 1.0–3.0 μ, commonly 55–65 × 1.5–2.5 μ (FIG. 1, *A*).

Imperfect fruiting bodies infrequently found, inconspicuous, developing from light-colored, sub-phellar, erumpent stromata; with age becoming multiloculate and the outer wall and overlying bark more or less completely lost. **Conidiophores** erect, entirely lining the locules; simple or sparsely branched, noticeably septate, hyaline, minutely guttulate; bearing sparsely at the sides and sparsely or profusely at the apices the unicellular, curved, subulate spore-bearing elements (phialides [7]). **Conidia** abstricted from the acute tips of the phialides, hyaline, continuous (germination not observed), very thin-walled, usually long-elliptical to ovate, occasionally allantoid, size range 2.5–4.0 × 0.5–1.5 μ (FIG. 1, *D & E*).

[7] After Mason (**1937**: 86–89).

TYPE SPECIMEN

The existence of a type specimen has not been reported and no effort was made to locate one in the course of the present study.

SPECIMENS EXAMINED

Exsiccati apparently correctly designated as *D. calyciformis*: Rehm, Ascomyceten *1163* (1896), "*Dasyscypha calyciformis* (Willd.)" (NY.); containing twenty or more well preserved apothecia and no imperfect fruiting bodies. A tabular summary, showing the similarity between the perfect stage of this exsiccatus, the perfect stage of the fungus as described by Rehm (**1893**: 834–835), and the perfect stage of the fungus as described by Jørstad (**1925**: 39), Schellenberg (**1905**: 270), and Maublanc (**1904**: 234), follows.

	Asci	Ascospores	Paraphyses	Hairs
Ascomyceten *1163*	43–51.5 ×4–6 μ	4–7×2–3.5 μ	49.5–71.5 ×1.5–2.5 μ	3 μ wide
Rehm's description	50–60 ×4.5–5 μ	5–7×2.5–3 μ	1–2 μ wide	3.5–4 μ wide
Jørstad's description	—	5–7.5 ×2–3 μ	—	—
Schellenberg's description	50–60 ×4–7 μ	5–8×2–3 μ	50–60 μ long	—
Maublanc's description	40–50 ×4–4.5 μ	6–8×2.5–3 μ	—	—

It can be seen that the exsiccatus fits Rehm's description quite closely in these characters of the perfect stage. More complete examination of the exsiccatus makes it an even better fit; accordingly the identity of specimens here designated as *D. calyciformis* is determined by comparison with this exsiccatus. Jørstad's, Schellenberg's, and Maublanc's measurements indicate that the fungus believed to be *D. calyciformis* today is probably the same as Rehm's *D. calyciformis*.

Kryptogamae exsiccatae *954* (1904)., "*Dasyscypha calyciformis* Rehm apud Rabenh." (NY.); containing ten to fifteen good apothecia which are both overmature and molded, as well as a few imperfect fruiting bodies. The overmaturity and weathering have contributed in making the ascospores irregular in shape; otherwise

the perfect stage of this exsiccatus fits closely the perfect stage of Rehm's *D. calyciformis* as exemplified by his *1163*.

Kryptogamae exsiccatae *1821* (19??), "*Dasyscypha calyciformis* Rehm apud Rabenh." (NY.); containing ten to fifteen good apothecia and several imperfect fruiting bodies. It compares closely with the perfect stage of the Rehm exsiccatus in all respects.

Krieger, Fungi saxonici *916* (1894), "*Dasyscypha calyciformis* (Willd.) Rehm" (NY.); containing a few good but severely weathered apothecia and no imperfect fruiting bodies. Despite the weathered condition the characters of the perfect stage are quite similar to those of the Rehm exsiccatus.

Jaczewski, Komarov, & Tranzschel, Fungi rossiae exsiccati *244* (1896), "*Dasyscypha calyciformis* (Willd.) Rehm" (NY.); containing a generous number of well preserved apothecia but no imperfect fruiting bodies. The perfect stage is quite similar to the perfect stage of Rehm's exsiccatus.

Exsiccati apparently incorrectly designated or cited as *D. calyciformis:* Allescher & Schnabl, Fungi bavarici *169* (1891), *Dasyscypha calycina* (Schum.) Fries" (Path. & Myc. Coll., U. S. D. A., Wash., D. C.: BPI.), cited by Rehm (**1893**: 834) as representing *D. calyciformis;* de Thümen, Mycotheca universalis *1508* (1880), "*Dasyscypha calycina* Fuck." (BPI.), cited by. Rehm (*loc. cit.*) as representing *D. calyciformis;* D. Saccardo, Mycotheca italica *672* (1901), "*Dasyscypha calyciformis* Sacc." (NY.); Sydow, Mycotheca germanica *905* (1910), "*Dasyscypha calyciformis* (Willd.) Rehm" (Mo. Bot. Gard. Herb., St. Louis, Mo.: MO.).

Exsiccati of uncertain identity: Rabenhorst, Herbarium mycologicum *422* (1857), (BPI.), cited by Rehm (*loc. cit.*) as representing *D. calyciformis,* but "material of no value" teste Edith K. Cash; Rabenhorst-Winter, Supplement, Fungi europaei *1422b* (1871), "*Dasyscypha calycina* Fries" (BPI.), cited by Oudemans (**1919**: 367) as representing *D. calyciformis,* but Rehm (**1893**: 834) cites, with question, only the exsiccatus *1422* which is apparently distinct from the supplement *1422b*.

Other specimens apparently incorrectly designated as *D. calyciformis:* Michigan State College Herb. (MICH.) "Fp *78*"; C. R.

Stillinger *1412, 2297,* & *2602;* J. R. Hansbrough *578* & *579* (NY.) ;
University of Idaho Forest Pathology Herb. *1341, 1347, 1467,
2202,* & *2829.* None of these eleven American collections, deter-
mined or tentatively determined as *D. calyciformis,* is considered
to be correctly designated on the basis of comparison with the
Rehm exsiccatus (Ascomyceten *1163*).

HOSTS AND GEOGRAPHICAL RANGE

The five correctly designated exsiccati which have been exam-
ined are all on *Abies* from Austria, Germany, Hungary, or Russia.

A fairly comprehensive literature survey reveals that *D. calyci-
formis* ranges widely over the European countries where it occurs
most frequently on *Abies.* Jørstad (**1931**: 78–96) reported the
fungus on *A. alba* Mill., *A. balsamea* (L.) Mill., *A. cephalonica*
Loud., *A. concolor* Lindl. & Gord., *A. Fraseri* Poir., *A. grandis*
Lindl., *A. nobilis* Lindl., *A. nordmanniana* Spach., and *A. sibirica*
Ledeb. in Norway. Falck (**1927**: 397–409) and Plassmann
(**1928**: 272–283) reported the fungus on *Abies* in the Eifel district
of Germany, Plassmann (**1927**: 18–19) having previously reported
the fungus on *Pinus Strobus* L., *P. sylvestris* L., and *Picea* at
Hann.-Münden, Germany. Schellenberg (**1905**: 269–286) re-
ported the fungus on *Abies sibirica* and *A. alba* from Adlisberg,
Germany; while Rehm (**1893**: 834–835), in redescribing the spe-
cies, reported it on branches of *A. alba, Pinus Mugo* Turra var.
pumilio Zenari, and (?) *Pinus larix* from Switzerland, Germany,
and Austria. Ferdinandsen (**1928**: 275) reported the fungus on
Pinus contorta Dougl., *Picea abies* Karst., and *P. sitchensis*
(Bong.) Carr. from Denmark. Zederbauer (**1906**: 1) reported
the fungus on *Picea abies* Karst. from Bohemia and Austria.
Maublanc (**1904**: 235) reported the fungus on *A. alba, Larix,* and
Pinus from France; Vuillemin (according to Maublanc) reported
it on *Picea,* also from France. Noack (**1928**: 707) reported it
on *Pinus Mugo* and *Larix decidua* Mill. Wilson (**1921**) re-
ported the fungus from Great Britain, Feltgen (**1903**: 66) from
Luxemburg, Strasser (**1902**: 435) from northern Hungary, and
Ludwig (**1894**: 337–338) from Graz, Austria. None of these last
four publications has been seen even in satisfactory abstract form
so the hosts have not been ascertained.

It would seem then that, although *Abies* is most frequently the host upon which *D. calyciformis* occurs, the fungus may also occur on *Pinus, Larix,* and *Picea* with some frequency. The fungus is presumably European in geographic range as all the records and specimens which have been seen come from the European countries. However, lists from continents other than North America and Europe have not been examined.

ILLUSTRATIONS SEEN

Rehm in Rab. Krypt.-Fl. 1 (3): 825, *fig. 7.* 1893; Maublanc in Bull. Soc. Myc. Fr. 20: 235, *fig. 1–8.* 1904; Schellenberg in Schweiz. Centralanst. Forstl. Versuchw., Mitt. 8: *pl. I, fig. 1–3; pl. II, fig. 1–13.* 1905; Plassmann, Untersuchungen über den Lärchenkrebs, *fig. 5–8.* 1927.

PARASITISM

European mycologists who have studied *D. calyciformis* seem to consider it, except in a few cases, saprophytic or mildly parasitic. Thus Jørstad (**1925**: 39 & 116) considered the fungus a saprophyte on *Pinus sylvestris* although of some importance, but not producing real cankers, on *Abies,* especially *A. balsamea.* Jørstad (*ibid.:* 116) implied that it is only weakly parasitic as he reported that it is often found associated with dead and dying *Abies* but is mainly saprophytic. Falck (**1927**: 397–409) reported that he found *D. calyciformis,* with other fungi and an aphid, involved in a die-back disease of *Abies;* but Plassmann (**1928**: 272–283) later reported that the disease was largely due to the insect attack and that the fungi, including *D. calyciformis,* were acting in a saprophytic capacity, evidently secondary to the attack of the aphid. Zederbauer (**1906**: 1) reported *D. calyciformis* as a wound parasite of considerable frequency on *Picea,* while Ferdinandsen (**1928**: 275) reported it as a wound parasite causing damage on artificially regenerated *Pinus contorta* but of small importance on *Picea abies* and *P. sitchensis.* Maublanc (**1904**: 233) reported that he had found the fungus on bark already parasitized by *Armillaria mellea* (Vahl ex Fries) Fries; Vuillemin (according to Maublanc) reported the fungus to be a saprophyte, developing in wounds. Schellenberg (**1905**: 284–286) found that the fungus

caused inconsequential damage on suppressed or injured twigs of *A. alba* but severe damage on vigorous branches and trunks of *A. sibirica*. Noack (1928: 707), following Wagner (1896: 321), said it was usually found as a saprophyte, but sometimes as a parasite, especially in young trees and on damp sites.

DISCUSSION

It is realized that the value of the foregoing description is limited by the small number of specimens available for study, none of them fresh. The description, in fact, is based on five exsiccati of which only one (Rehm, Ascomyceten *1163*) can be considered as determinative. Examination of these few exsiccati has not provided a complete understanding of Rehm's fungus but the description is believed adequate for distinguishing the other *Dasyscyphae* under consideration from this fungus. It is not known whether a type specimen exists today because collections in European herbaria have not been available for study. A recent letter from Miss E. M. Wakefield merely reports the absence of any Rehm specimens of this species in the Herbarium of the Royal Botanic Gardens at Kew (K.).

Information concerning hosts, geographical range, and parasitism is taken from the few specimens examined and from the fairly completely covered literature. The difficulty in obtaining herbarium specimens from countries abroad and the limited time available for literature survey prohibit a more exhaustive study of these features at this time.

D. calyciformis, as exemplified by the Rehm exsiccatus, is also believed distinct from other small- and large-spored *Dasyscyphae*. Authentic materials of the small-spored species, *D. resinaria* (Cooke & Phill.) Sacc. and *D. subtilissima* (Cooke) Sacc., have not been examined. The published descriptions, however, show these species to differ from *D. calyciformis* in ascospore and ascus size as well as in other morphological features. Jørstad (1925: 39) has only recently verified the differences in ascospore size. Hahn and Ayers (1934) have thoroughly described the large-spored species *D. calycina* Fuckel and *D. Willkommii* (Hartig) Rehm, and Plassmann (1927: 18) and Schellenberg (1905: 270)

have shown in convenient tabular summaries how the asci, asco-spores, and paraphyses of *D. calyciformis* differ from those of *D. Willkommii*, so that there should be no confusion with these species. Noack (**1928**: 707) pointed out that the discs of *D. calyciformis* are not orange as in other species, but pure yellow.

The imperfect stage, as far as can be determined, has never been assigned to a form-genus nor given a specific name. Maublanc (**1904**: 234) and Schellenberg (**1905**: 274) pointed out that Rehm (**1893**: 835) was in error when he suggested *Phoma abietina* Hartig as the imperfect stage.

DASYSCYPHA AGASSIZII

Among the small-spored American *Dasyscyphae, D. Agassizii* (Berk. & Curt.) Sacc. is perhaps the most widely found and uni-versally recognized. According to Snell (**1929**: 242) it is fairly closely limited to the northeastern part of this continent. As de-termined from many specimens in NY., the Farlow Herb. (FH.), the Brown Univ. Herb. (BRU.), the Dodge Herb. (then at Har-vard), the Overholts Herb. (Penn. State College), and BPI., he reported the geographical range to be sub-boreal (north of 43° 30′ north latitude) with only a few specimens from west of the Mis-sissippi River. Snell (*ibid.:* 235–242) also reported that *D. Agassizii* was frequently found on blister rust cankers of *Pinus Strobus* L. in New York. In so doing, Snell raised a question in the minds of northwestern collectors as to whether the similar small-spored *Dasyscypha* on blister rust cankers of *P. monticola* (described later in this paper) might not also be *D. Agassizii.*

The literature shows that the morphological characters of *D. Agassizii* vary among individual specimens. Thus Berkeley (**1875**: 151), in his original publication of the species, described the ascospores as narrowly oblong or subfusiform, about 5.1 μ (.0002″) long. In the Sylloge, Saccardo (**1889**: 438) described the ascospores as ellipsoid-ovate or subfusiform, 6.5–7.5 × 4 μ in size. Snell (*op. cit.:* 240) reported the ascospores as large as 10.5 × 5.25 μ (on *Abies*) and as small as 6.5–7.5 × 3–3.5 μ (on *Picea*).

Dasyscypha Agassizii, as far as can be determined, has not been redescribed since Saccardo (**1889**: 438) included it in the Sylloge.

Because there is a difference of opinion in the literature as to spore size and shape, and because it has been confused with the two other small-spored *Dasyscyphae* discussed in this paper, authentic material has been studied. An amended description, based on thirty specimens including a slide of the isotype specimen, follows.

DASYSCYPHA AGASSIZII (Berk. & Curt.) Sacc. Syll. Fung. 8: 438. 1889.

> *Peziza (Humaria) Agassizii* Berk. & Curt. in Grevillea 3: 151. 1875.

Apothecia abundant, subphellar or shallowly intra-phellodermal, erumpent, gregarious or solitary, often several from a common subicle-like base; *stipes* moderately long to long, up to 2.5 mm., each with from one to as many as a dozen cups; *cups* when young tightly closed, with age opening circularly and expanding under moist conditions to a disc-like form with a very thin, undulating margin, drying circularly when young but with age drying irregularly either by a partial inward curling or by folding across the disc, externally whitish with excipular hairs; *hairs* cylindrical, thin-walled, moderately to considerably roughened by minute tubercles, with unswollen or slightly swollen, rounded, occasionally sub-acute tips, noticeably septate at 10–25 μ intervals, 2.5–4.5 μ wide, always present on the younger apothecia but not persistent, often entirely missing except at the margins on the older apothecia (FIG. 2, *C*); *discs* yellow to bright orange, large, 0.5–5.5 mm. wide, mostly 1.5–4.0 mm. wide; *hyphae* of the context variable in width, 2.0–6.0 μ wide, septate, irregularly swollen, much branched at various angles. **Asci** cylindrical to clavate, with rounded or sub-acute apices, size range (250) 43.5–67.5 × 4.0–6.0 μ, commonly 47–60 × 4.5–5.5 μ (FIG. 2, *A*). **Ascospores** eight, *arrangement* uniseriate, oblique with the basal spores almost vertical, occasionally irregularly arranged or with a change in the direction of the oblique arrangement, rarely biseriate; enclosing *membrane* usually flattened or slightly concave, not following the contour of the ascus at the apex; *shape* usually elliptical to plump-ovate, extreme range from subfusiform to almost spherical, occasionally with one end (the lower when in the ascus) slightly more acute or collapsed; *walls* thin; *contents* hyaline, indistinctly nucleate and either biguttulate or uniguttulate, continuous (germination not observed) or rarely uniseptate both inside and outside the ascus; *size* range (660) 5.0–9.5 × 2.0–4.0 μ, commonly 5.5–8.5 × 2.5–3.5 μ (FIG. 2,

A & *B*).   **Paraphyses** usually exceeding the asci by from 5 to 15 μ, relatively stout and coarse, smooth, occasionally branching near the base; *shape* usually distinctly swollen to almost spatulate at the tips, tapering more or less sharply past other swellings in the upper portion, to the base, the swollen paraphyses intermixed with smaller
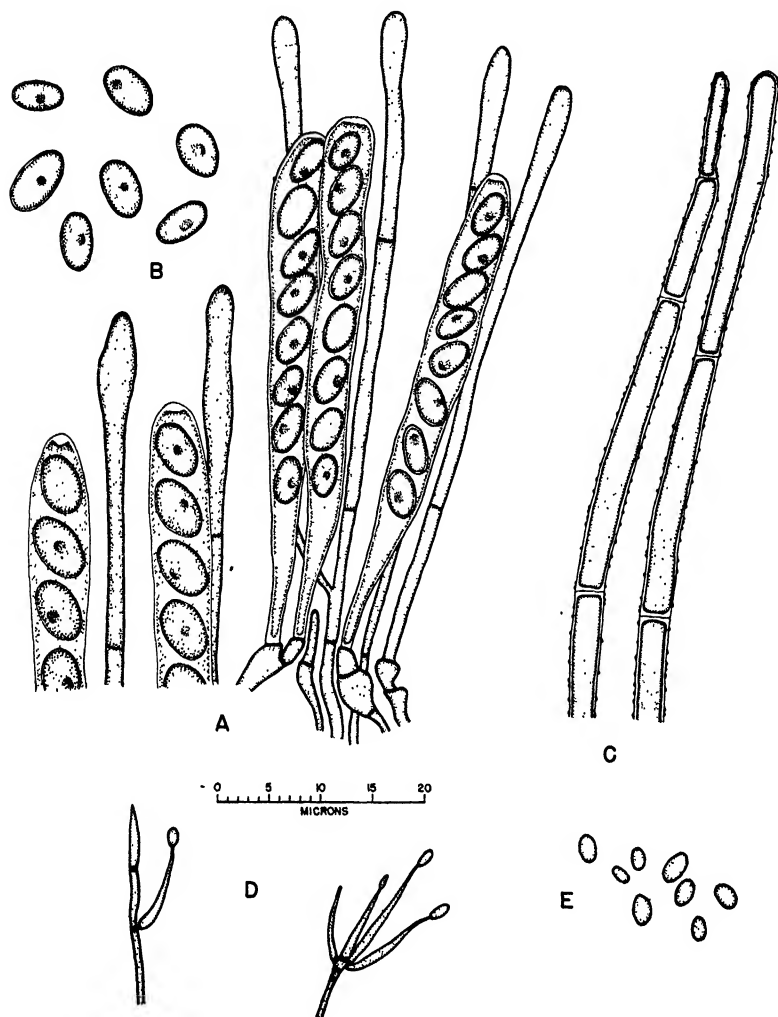

FIG. 2. *Dasyscypha Agassizii* (Berk. & Curt.) Sacc. Drawings made with aid of a micro-projector; those of the perfect stage from Walter H. Snell *703* and *1825*, those of the imperfect stage from L. O. Overholts *4841*. *A*, asci and ascospores; *B*, ascospores; *C*, excipular hairs; *D*, conidiophores and phialides; *E*, conidia.

numbers of shorter and more slender, cylindrical paraphyses, tips rounded or sub-acute; *contents* obscurely or clearly septate, minutely guttulate; *size* range (240) 47.5–94.5 × 1.0–3.5 μ (at the widest point), commonly 65–85 × 2.0–3.0 μ (FIG. 2, *A*).

Imperfect fruiting bodies very infrequently found, inconspicuous, developing from light-colored, sub-phellar, erumpent stromata; with age becoming multi-loculate, and the outer wall and overlying bark more or less completely lost. **Conidiophores** erect, entirely lining the locules, simple or freely branched, noticeably septate, hyaline, minutely guttulate; bearing sparsely at the sides, and sparsely or profusely at the apices, the unicellular, curved, moniliform or only slightly subulate spore-bearing elements (phialides). **Conidia** abstricted from the acute apices of the phialides, hyaline, continuous (germination not observed), very thin-walled, once seen exuded from the top of a mature stroma in a whitish, translucent mass, usually elliptical or ovate, size range 1.5–4.5 × 0.5–3.0 μ (FIG. 2, *D* & *E*).

TYPE SPECIMEN

Berkeley (**1875**: 151) designated no type specimen but cited two Curtis Herbarium numbers: "On bark.   Lake Superior, Agassiz. No. *2631*.   New England, Oakes.   No. *3098*."   Snell (**1929**: 238) has pointed out that the host of *2631* was indicated by Curtis as "in cort. Pini" and by Saccardo as "in corticibus Abietis"; a slide prepared from this number (FH.) by Hahn and Ayers is labelled "on Pine."   The New England specimen (*3098*, FH.) is labelled "trunc. Abietis?" in Curtis' handwriting and Snell (*loc. cit.*) has confirmed this as *Abies balsamea*.   Miss Wakefield (**1942**: Personal communication) reported merely that "there is a type specimen" at Kew.

In view of these circumstances, Curtis' *2631* at Kew may be designated as the type specimen, *3098* at Kew as the paratype,[8] *2631* at the Farlow as the isotype,[8] and *3098* at the Farlow as part of the paratype.   Alternatively, both *2631* and *3098* at Kew may be regarded as type specimens and those at the Farlow as isotypes.

SPECIMENS EXAMINED

Isotype specimen: Curtis Herb. *2631,* "*Peziza Agassizii* B. & C." (FH.); now containing only two apothecia—teste Dr. Linder.

[8] After Ewan (1942: 8–9).

The specimen itself was not seen, but a slide of the perfect stage containing ascospores, asci, paraphyses, excipular hairs, and context hyphae, made by G. G. Hahn and T. T. Ayers in 1931, was kindly loaned by Dr. Linder. This slide served to verify the opinion that *D. Agassizii* is a distinct species as it contains all the features of the perfect stage, notably the flat-topped ascus membrane and the swollen paraphyses tips, believed diagnostic for this species. Hahn's (**1942**: Personal communication) measurements of ascospores, presumably from this slide, were given as 5.8–8.9 × 3.0–4.4 μ. Measurements of ascospores from the same slide, made during this study, differed, being (40) 4.5–9.0 × 2.0–4.0 μ. The smaller length and width of the latter measurements is probably due to the manner in which ascospore measurements were taken throughout the study; *i.e.*, no satisfactory means for determining the maturity of ascospores outside the ascus having been found, the ascospores were measured as encountered in the microscope field, avoiding only collapsed or distorted spores.

Exsiccati apparently correctly designated as *D. Agassizii:* Rehm, Ascomyceten *1854* (1909), "*Dasyscypha Agassizii* (B. & C.) Sacc." (NY.), on *Abies balsamea* from Wisconsin; Ellis, North American Fungi *1311* (1885), "*Peziza Agassizii* B. & C." (three specimens: from the Ellis Collection, from the Columbia College Herb., and from the Underwood Collection; all in NY.), on dead limbs from New Hampshire.

Other specimens apparently correctly designated as *D. Agassizii:* W. S. Snell *703, 1459, 1586, & 1825;* W. G. Farlow (NY., & MO. *18433*); L. M. Underwood, North American fungi (two specimens from the Underwood Collection, NY.); W. A., & E. L. Murrill, Fungi of Lake Placid *261* (NY.); L. O. Overholts *4841* (MO. *55828*); B. L. Robinson & H. Schrenk, Flora of Newfoundland, distributed by the Harvard University Herb. (NY., & MO. *18268*); J. B. Ellis & A. C. Waghorne, Newfoundland fungi *65* (MO. *18428*); H. C. Peck & A. C. Waghorne, Labrador fungi *18* (MO. *18429*); University of Toronto Cryptogamic Herb. *7908* (NY., & Oregon State College Herb. (OSC.) *9802*); MO. *150902;* J. Ehrlich *841, 843, 844, 922, 981, & 1116.*

Other specimens apparently incorrectly designated as *D. Agassizii:* C. R. Stillinger *2221;* E. E. Honey (NY.); MO. *18430* &

55451; Wm. Bridge Cooke *67* (MO. *156204*) ; University of Idaho Forest Pathology Herb. *2058.*

Other specimens of uncertain identity: S. M. Zeller *6799* ("*Dasyscypha Agassizii* (Berk. & Curt.) Sacc. var. *rufipes* Phill.") ; W. A., & E. L. Murrill, Fungi of Lake Placid *554* (NY.) (lacks apothecia).

HOSTS AND GEOGRAPHICAL RANGE

Specimens have been examined on *A. balsamea, A. Fraseri,* and *Abies* sp. from Maine, New Hampshire, New York, North Carolina, Wisconsin, Labrador, New Brunswick, Newfoundland, Nova Scotia, and Ontario; on *Pinus Strobus* from New York; and on unknown hosts from New Hampshire and New York.

Snell (**1929**: 236–240) collected *D. Agassizii* on *Picea rubra* in New York; and reported specimens in NY. on *Abies balsamea* from Pennsylvania, and in the C. W. Dodge Herb. on *A. balsamea* from Quebec. Snell also reported specimens in FH. on *Tsuga canadensis* (L.) Carr., in NY. on *Picea, Pinus,* and *P. monticola,* and in BPI. on *Picea mariana* (Mill.) Britt. et al. without giving the geographical range; specimens in FH. from Vermont, and in BPI. from Massachusetts, Montana, and Idaho without giving the hosts. Seymour (**1929**: 30 & 49) reported *D. Agassizii* on *Pinus contorta* and on *Larix laricina* (Du Roi) K. Koch. Bisby (**1938**: 39) reported *D. Agassizii* on *Abies balsamea* from Manitoba.

It is believed that most of the northwestern material designated as *D. Agassizii* is incorrectly determined, as none of the northwestern material examined during this study has been found to be characteristic. *D. Agassizii,* then, seems to be found most frequently on *Abies,* particularly *A. balsamea;* next most frequently on *Pinus,* particularly *P. Strobus;* and infrequently (not verified) on *Larix, Picea,* and *Tsuga.* In geographical range it appears to be limited to the northeastern part of this continent, occasionally (not verified) in outlying western states.

ILLUSTRATIONS SEEN

Cooke in Grevillea 3: *pl. 40* (*fig. 169*).   1875.

PARASITISM

Snell's (1929) report of *D. Agassizii* on presumably live blister rust cankers of *Pinus Strobus* and Ehrlich's (1932: 38) report of *D. Agassizii* on weakened *Abies balsamea* are the only discovered references to this fungus occurring on live tissues. All specimens examined either stated on their labels that the host was dead or failed to record the host relationship. *D. Agassizii* would seem to be only a weak parasite acting as a secondary fungus on already weakened tissues or, most often, a pure saprophyte.

DISCUSSION

The amended description given, based on thirty specimens including an isotype specimen, serves to distinguish *D. Agassizii* from its close relatives, the European *D. calyciformis* and a *Dasyscypha* found on *Pinus monticola* in the Northwest. The principal distinguishing characters of *D. Agassizii* were found to be the size of the ascospores (slightly larger than in either of the other species under consideration), the often swollen tips of the paraphyses (not swollen in either of the other species), and the flat-topped ascus membrane (following the contour of the ascus in the other species). It may be distinguished from other small-spored *Dasyscyphae* on the basis of ascospore size and shape alone. It possesses an infrequently found imperfect stage like that in *D. calyciformis*.

(To be concluded in a later issue)

TAXONOMY, DISTRIBUTION, AND PATHOLOGY OF PHOMOPSIS OCCULTA AND P. JUNIPEROVORA

GLENN GARDNER HAHN

(WITH 2 FIGURES)

INTRODUCTION

The heightened esteem of soil conservationists and the public generally, particularly in the Central States, for the eastern red cedar (*Juniperus virginiana* L.) is causing forest pathologists to focus their attention on diseases affecting the common cedar, the importance of which has increased greatly because of its present extensive use in planting projects. Red cedar is considered by many as being one of our finest ornamentals. In the Prairie States its value for farmstead windbreaks is recognized now as never before.

For approximately 50 years pathologists have been interested in a destructive nursery disease of the native red cedar known as cedar blight, which is caused by *Phomopsis juniperovora* Hahn. During the early period of the investigation of this juvenile disease from 1895 to 1920 (**3, 9, 10, 15**) a closely related *Phomopsis* was unknown. A few years later, however, such an organism entered the pathological picture and became a complicating factor in the identification of the nursery parasite. When first recognized the related *Phomopsis,* which was demonstrated by the writer to be nonpathogenic on two members of the Cupressaceae, was regarded as a physiological variety of the cedar-blight organism (**4**). Later investigations showed it could be distinguished morphologically from *P. juniperovora,* and he identified it as *P. occulta* (Trav.) Sacc., while studying the genus *Phomopsis* on conifers in Great Britain during 1926 to 1929 (**3**). Since *P. occulta* is widely distributed in the United States and since it is to be found on dead branchlet tips of wildling as well as nursery stock of east-

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ern red cedar, its presence has confused the identification of the true cedar-blight pathogen on both kinds of stock unless careful laboratory studies are made.

The control of cedar blight continues to be a most refractory problem in Federal and commercial nurseries of the States of the Mississippi Valley and in the Southeast.   Inasmuch as our present knowledge of the life history of the causal organism on wildling junipers and its dissemination from this source is limited, it was important that information be obtained on the related *Phomopsis occulta* in order to determine whether or not it was to be considered a potential factor in nursery infection.   Accordingly an investigation [1] of *P. occulta* on eastern red cedar was carried out, the results of which demonstrated its nonpathogenicity on this valuable conifer.

INOCULATIONS WITH PHOMOPSIS OCCULTA AND P. JUNIPEROVORA

The investigation of *Phomopsis occulta* was concerned with the problem of determining whether it was parasitic to any degree upon wildling red cedar.   Comparable tests were performed at the same time with the cedar-blight parasite, *P. juniperovora,* which were used as a "check" to establish the suitability of the environmental conditions for the experiments.   The inoculations were performed June 16 to 18, 1941 on vigorous 3- to 6-year-old potted stock of the wildling reproduction of eastern red cedar that had been obtained earlier in the spring in the field near Durham, Connecticut.   The tests were carried on in an unheated greenhouse in the Marsh Botanical Garden, Yale University, New Haven.   The cedars, which for the most part averaged 30 inches in height, apparently were unaffected by transplating.   Some of them showed the presence

of numerous galls of the cedar-apple rust, *Gymnosporangium juni-peri-virginianae* Schw.

The inocula utilized for the tests consisted of monospore cultures of *Phomopsis juniperovora* and *P. occulta* growing on synthetic malt agar. The former was isolated from pycnidia that occurred abundantly on badly diseased Rocky Mountain juniper (*Juniperus scopulorum* Sarg.) nursery seedling stock collected at a Federal nursery at Fremont, Nebraska, September 1940. The latter was obtained also from pycnidia on eastern red cedar from two sources, namely, a dead branchlet tip of diseased 3- to 5-year-old nursery stock collected in Maryland near the District of Columbia, January 6, 1941, and a similar branchlet taken from wildling material collected at Quissett (Falmouth), Massachusetts, February 1, 1941. In these two instances *P. occulta* appeared sparingly and occurred along with other fungi, *c.g.*, in the Maryland material a species of *Fusarium* occurred abundantly, whereas in the Massachusetts material *Cytospora* and *Pestalozzia* were observed among other saprophytes. In both cases the two collections had been submitted to the writer for diagnosis with the possibility that the *Phomopsis* might be the cedar-blight pathogen. Two individual but culturally similar isolates of each of the three collections mentioned above were used in the tests.

The technique employed in making the wound inoculations, which were placed only on the trunk, has been described in a previous paper (4). A single check incision was placed on each tree below the inoculated incisions.

RESULTS WITH P. OCCULTA

A total of 14 saplings were tested with *Phomopsis occulta* with the following pure cultures: Maryland collection—6 trees with the first isolate and 2 trees with a second isolate; Massachusetts collection—4 trees with the first isolate and 2 trees with a second isolate. All of the plants failed to show cankering or a blighted condition and both inoculated and check incisions healed without

Fig. 1. Negative results were obtained in two inoculations with *Phomopsis occulta* on this eastern red cedar wildling which was infected naturally with cedar-apple rust. The inoculated incisions and the check below are indicated by arrows. (Photographed by H. G. Eno, March 1942.)
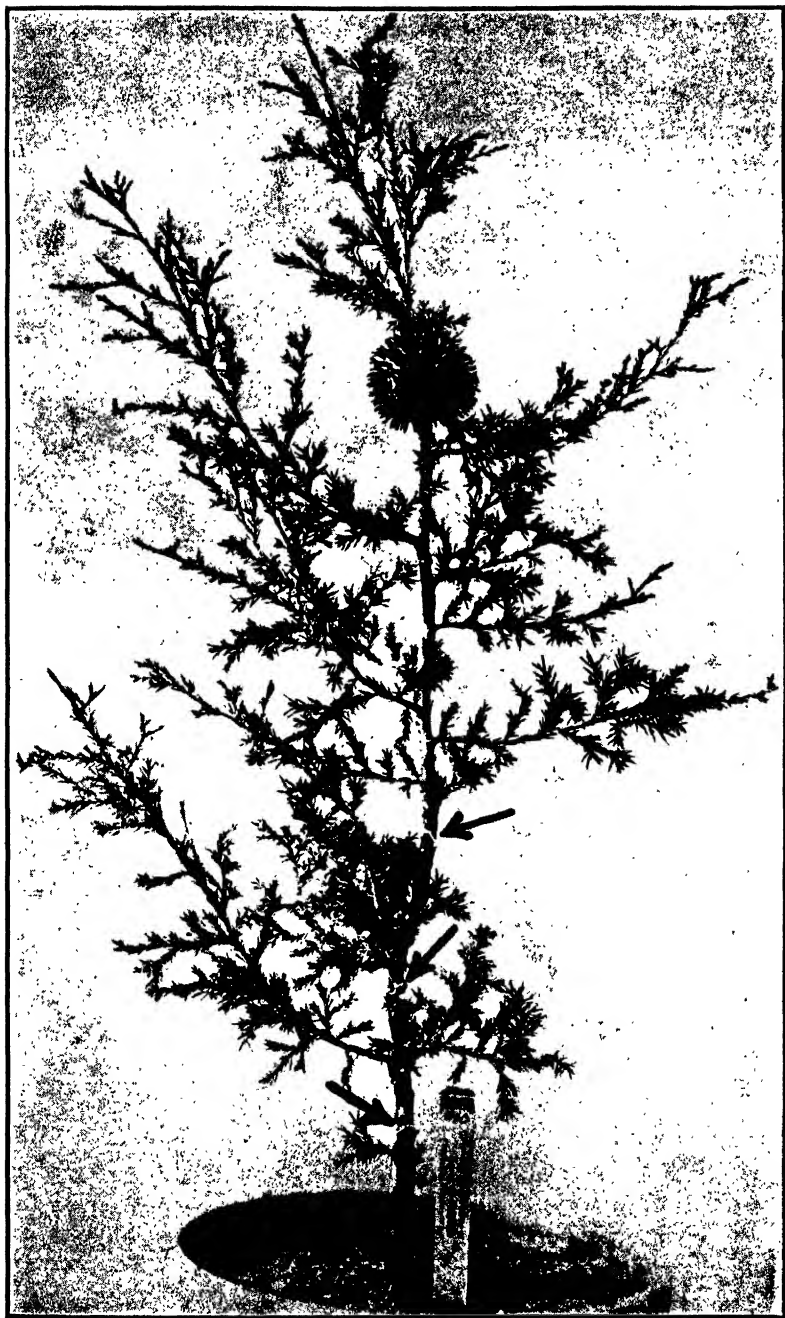
Fig. 1.

any fungus infection whatsoever. Included among the plants was a weakened sapling showing a large cedar-apple gall on its main stem. Despite the presence of this abnormality, the diseased condition of the wildling did not predispose it to infection of *P. occulta* (FIG. 1).

During the tests there appeared a natural colony of *P. occulta,* which was discovered in February 1942 growing below a colony of *Pestalozzia* at the tip of a very small dead branchlet apparently dead from natural causes. It is not known whether *P. occulta* was brought into the greenhouse from the field on the plant itself or whether it came from inoculum already present in the vicinity of the greenhouse where in the past the fungus has been collected on dead twigs of Douglas-fir (*Pseudotsuga taxifolia* (Poir.) Britton). Monospore cultures of the cedar collection of *P. occulta* showed agreement with isolates of the saprophytes used in the foregoing tests.

RESULTS WITH P. JUNIPEROVORA

A total of 7 saplings was tested with the cedar-blight parasite, 5 trees being inoculated with the first isolate and 2 trees with a second isolate. All of the saplings tested were 5 to 6 years old and one of them, a forked plant, was tested similarly with both species of *Phomopsis,* the larger shoot carrying two *P. juniperovora* inoculations. A total of 14 inoculations were made and all of them showed cedar-blight infection but in varying degrees.

Five saplings for which the first isolate was used were girdled at all except one of the incisions. In three of the trees, which were of a distinct bluish-green color and which appeared to be most susceptible, the parasite by March 20, 1942 had progressed downwards in the cortical tissues from the lower incision, 4 cm., 5 cm., and 6 cm., respectively. The forked tree of this group was inoculated with both *Phomopsis* species; *Phomopsis occulta* failed to infect the slenderer shoot (FIG. 2), whereas the stouter shoot was attacked by the pathogen. The terminal of this shoot was girdled and killed by the upper infection but a nongirdling canker at the lower incision affected only the lateral branches on one side of the trunk above the inoculation (FIG. 2).

The two remaining cedars, which were of a lighter green color, were tested with a second isolate, and evinced cedar-blight resistance. One of these showed a blighted tip that had resulted from a girdling infection at the upper incision, whereas at the lower incision, a limited nongirdling canker formed and the laterals involved by it were not discolored. The other tree, which was lighter and brighter in color than the other, showed nongirdling cankers but no discoloration of lateral branches. It is here of interest to note that the "Hill Dundee" juniper (*Juniperus virginiana* var. *pyramidiformis* D. Hill), reported as being highly resistant to cedar blight (6, p. 56), is described by Rehder (13) as having also bright green foliage in summer.

One of the tested cedars, which was bluer in color than any of the others, was the first to show external evidence of disease. By mid-July its terminal was brown and lateral branches below were becoming discolored. By September 24, 1941 the parasite had extended its growth downward 6.5 cm. from the lower inoculation to invade the check incision. *Phomopsis juniperovora* was reisolated from this wildling on February 21, 1942 at which time the pathogen was recovered in a pure condition 8 cm. below the lower inoculation, and also at a point midway between the two inoculations placed on the main trunk, 10.5 cm. from each incision. The reisolated parasite produced the yellow coloration accompanied later by flaming orange crystals (3, 5, 9) in a synthetic malt substratum, both color and crystals being characteristic of the physiological activity of *P. juniperovora* growing on a number of agar media. A fine blackened line or zone within which perithecia of *Diaporthe* may be formed was observed in the cortex 2 cm. above the lower incision, similar to that described and illustrated by Wehmeyer (18, pl. III).

It was not possible to reisolate *Phomopsis juniperovora* from the dead tissues of the slender terminal distal to the upper inoculation on this very susceptible blue wildling. Moreover, no fruiting bodies of the parasite were found on the trunk or the dead laterals killed by girdling. The laterals were colonized, however, by secondary fungi—*Botrytis, Alternaria, Pestalozzia,* etc. Pycnidia, moreover, were not observed on any of the other trees tested with the cedar-blight parasite. In earlier studies the writer obtained

fruiting bodies of *P. juniperovora* on inoculated 2-year-old red cedar nursery stock (**9**, pl. 61).

DISCUSSION OF THE TAXONOMY, DISTRIBUTION, AND PATHOGENICITY OF THE TWO RELATED PHOMOPSIS

Because of the close morphological similarity between *Phomopsis occulta* and *P. juniperovora,* the distribution of the latter as an endemic parasite on the common red cedar has been confused. This has been especially true where diagnoses of the pathogen have been made on wildling junipers.

P. occulta

A previous biometrical study made by the writer (**5**, p. 56) of the size of A-spores of *Phomopsis occulta* distinguished them from those of the cedar-blight pathogen.   While there is overlapping of the spore size ranges of the two species, A-spores of *P. occulta* were found to be slightly longer than those of *P. juniperovora* and significantly different with regard to this character; the A-spores of the former gave a mean of 7.5 μ (collections from *Pseudotsuga*) and 7.2 μ (collection from *Thuja*), while those of the latter gave a mean of 8.7 μ (collections from *Juniperus*).   At the same time the writer reported that the filamentous B-spores of· *P. occulta* are inclined commonly to be bent at one end like ̄a walking stick, whereas those of *P. juniperovora* tend to be straighter.   Intermediate spores, moreover, are found more frequently in *P. occulta* than in *P. juniperovora*.

Where there is any doubt in the mind of the investigator concerning a morphological distinction, the two species of *Phomopsis* may be differentiated with certainty by cultural characters that are striking and constant.   *Phomopsis juniperovora* produces yellow coloration in the medium accompanied by flaming orange crystals on synthetic malt agar as well as on a number of other media (**3, 5, 9**); neither the yellow color nor the crystals appear in cultures of *P. occulta* on the same media.

While in Great Britain in 1926 to 1929 (**5**, pp. 75–76), the writer investigated the life-history of *P. occulta* and demonstrated that it belonged to *Diaporthe conorum* (Desm.) Niessl (syn. *D.*

occulta (Fuckel) Nit., *D. pithya* Sacc.).   According to Wehmeyer (18) *Diaporthae* on conifers including *D. conorum, D. occulta, D. pitya, D. pinophylla* Plowr. & Ph., *D. pinicola* Hazl., *D. conigena* Feltg., and probably *D. thujana* Petr. are all forms of *D. eres* on conifers.   The last named *Diaporthe* described on *Acer* is given by Nitschke as the type of the genus, and because of this Wehmeyer (18) has retained its name for an exceedingly large species complex of related host forms although *D. conorum* holds priority. The fact that the writer succeeded in obtaining fruiting bodies of *D. conorum* on sterilized twigs of English elm (*Ulmus procera* Salisb.),[2] from monopycnidiospore cultures derived from monoascospores taken originally from Douglas-fir, upholds in a measure Wehmeyer's opinion of the relationship of the conifer species to *D. eres.*

In the United States the writer has collected or identified *Phomopsis occulta* on a wide range of conifer hosts in both the eastern and western sections of the country (4).   These hosts are represented by the following genera: *Abies, Cephalotaxus, Cryptomeria, Cupressus, Juniperus, Larix, Picea, Pinus, Pseudotsuga, Sequoia, Taxodium, Taxus, Thuja,* and *Tsuga.*   In western Europe *P. occulta* is also widely distributed on numerous conifer hosts (5).

The perfect stage, *Diaporthe conorum,* also may be collected commonly in Europe whereas in North America it occurs apparently with great rarity, if at all.   Although the writer was able to find the perfect stage without difficulty in Great Britain, particularly in plantations of the exotic Douglas-fir, he has not come upon *Diaporthae* on conifers including Douglas-fir in this country despite extensive observations.

Wehmeyer's (18) studies of *D. eres* on conifers dealt with European specimens, some of which were sent him by the writer from Great Britain.   There is one exception, for Wehmeyer (18, p. 237) did report the species *D. disputata* Bomm., Rouss. & Sacc. (Ellis Herb. Myc. 189. 14 (2048), juniper, London, Ontario, Nov., 1903), which he stated is probably a form of *D. eres* (ascospores, 9.5–15 × 2.5–4 μ) on conifers.   This juniper species and *D. thu-*

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[2] Data contained in an unpublished manuscript entitled "Life-history studies of the species of *Phomopsis* occurring on conifers. Part II. *Diaporthe conorum* (Desm.) Niessl" by G. G. Hahn.

jana on *Thuja,* both described originally from European material, show ascospores that are slightly larger (12–17 $\times$ 3–5 μ) than the other *Diaporthae* on conifers.

Seymour (14) cited only two *Diaporthae* on conifers in North America, *Diaporthe griseotingens* (Berk. & Curt.) Sacc. and *D. disputata* on *Juniperus virginiana.* Wehmeyer (18, p. 254) reported the type of the former to be a *Physalospora* (*P. Cupressi?*). Moreover, in the collections of fungi deposited with the Division of Mycology and Disease Survey, Bureau of Plant Industry, all the specimens on conifers filed under *D. eres* or under the various other specific names listed by Wehmeyer (18) are European.

Inasmuch as *Diaporthe conorum* was collected commonly by the writer on Douglas-fir in Great Britain under environmental conditions very similar to those encountered in the Pacific Northwest, it was reasonable to expect that it would be found on native stands of that host in this country; for the imperfect stage of the species is present in the West on Douglas-fir, and inasmuch as the species is homothallic (5, p. 75), the presence of plus and minus strains is not required for the formation of the *Diaporthe* stage. However, to the best of the writer's knowledge *D. conorum* has not been collected in the Northwest. J. R. Hansbrough of the Division of Forest Pathology, who has collected widely in that locality, did not come upon the species.

In Europe *Diaporthe conorum* occurs as a saprophyte. This is also true of its imperfect stage, *Phomopsis occulta,* which the writer (5) found to occur as a secondary organism, particularly in cases of frost injury on such exotics as Douglas-fir. In this country his experience with *P. occulta* has indicated that generally speaking it is secondary following injuries caused by frost, transplanting, or drought, or those due to parasitic fungi, e.g., white pine blister rust (*Cronartium ribicola* Fisch.).

Contributory evidence of the nonpathogenicity of *Phomopsis occulta* on eastern hemlock (*Tsuga canadensis* (L.) Carr.) is given by the following investigators. G. H. Hepting of the Division of Forest Pathology at Asheville, North Carolina performed wound inoculation experiments in 1935 with the organism, isolated from diseased hemlock, on healthy plants of that species. Four tests made in October yielded negative results. Subsequently Hepting

proved that the hemlock twig blight was caused by the rust *Me-lampsora Farlowii* (Arth.) Davis (11). *P. occulta* was also iden-tified by the writer on diseased hemlock material submitted by B. O. Dodge, New York Botanical Garden. Dodge (2) reported that he was unable to induce blighting by spraying dormant hem-locks brought into a greenhouse with spore suspensions of the *Phomopsis* and he concluded that the organism was secondary.

The negative tests of *Phomopsis occulta* on eastern red cedar reported in this paper corroborate similar results obtained in the earlier studies (4) with the same fungus on Arizona cypress (*Cu-pressus arizonica* Greene) and Chinese arborvitae (*Thuja orien-talis* L.). Under nursery conditions both species may become quite susceptible to *P. juniperovora*. On the other hand the writer did obtain a certain amount of evidence that certain strains of *P. occulta* might become very weakly parasitic on Douglas-fir. In an early paper (4) he reported that under artificial conditions isolates of *P. occulta* obtained from diseased nursery stock of Douglas-fir and old ornamental trees of Irish yew (*Taxus baccata* L. var. *erecta* Loud.) produced a small amount of infection on potted saplings of the coast form of Douglas-fir.

P. juniperovora

The writer's experience with *Phomopsis juniperovora* has been confined almost entirely to investigations of the parasite on juvenile stock of members of the cypress tribe growing in Federal and commercial nurseries, and on nursery-grown shrubs transplanted to ornamental plantings. Eastern red cedar is the host most com-monly attacked, upon which the disease in certain epidemic years may become exceedingly virulent. A large number of species of the Cupressaceae are known to be affected by the pathogen, a re-vised list of which is given: [3]

[3] Most of the host species recorded were determined by the writer although duplicate reports of some of them by other observers are reported. The susceptibility of *Juniperus pachyploea* is known only from an artificial test conducted by the writer (9). Infected species indicated by an asterisk have not been studied by the writer but were reported by other investigators. White (19) reported spiny Greek juniper (*J. excelsa* var. *stricta*) and Kete-leer red redar (*J. virginiana* var. *keteleeri*) as being highly resistant to cedar blight. This is also true of the "Hill Dundee" juniper (*J. virginiana* var. *pyramidiformis*) (6, p. 56), which is not listed. The "Dundee" juniper has not been studied by the writer.

CHAMAECYPARIS—*Lawsoniana* (Murr.) Parl., *obtusa* (Sieb. & Zucc.) Endl., *pisifera* (Sieb. & Zucc.) Endl., *p.* var. *plumosa* (Carr.) Otto, *p.* var. *squarrosa* * (Endl.) Beiss. & Hochst.; CUPRESSUS—*arizonica* Greene, *a.* var. *bonita* Lemm. (*C. glabra* Sudw.), *Goveniana* Gord., *lusitanica* Mill. var. *Benthamii* (Endl.) Carr., *macrocarpa* Gord., *sempervirens* L., *s.* var. *stricta* Ait.; JUNIPERUS—*chinensis* L. var. *japonica* * (Carr.) Law., *c.* var. *mas* Gord., *c.* var. *Pfitzeriana* Spaeth., *communis* L., *c.* var. *sexatilis* Pall. (*c.* var. *montana* Ait., *J. sibirica* Burgsd.), *excelsa* Bieb. var. *stricta* * Gord., *horizontalis* Moench., *h.* var. *Douglasii* * Rehd., *lucayana* Britt., *mexicana* * (*J. ashei* * Buchh.) Schlecht., *pachyphlaea* Torr., *procumbens* (Endl.) Sieb. & Zucc., *Sabina* L., *s.* var. *tamariscifolia* Ait., *scopulorum* Sarg., *s.* var. *argentea* D. Hill, *squamata* Lamb. var. *Meyeri* * Rehd., *virginiana* L., *v.* var. *canaertii* Senecl., *v.* var. *Keteleeri* * Hort., *v.* var. *plumosa* * Rehd., *v.* var. *tripartita* Senecl.; THUJA—*occidentalis* L., *plicata* Lamb., *orientalis* L.

Under artificial conditions the writer in early studies (4, table 1) succeeded in obtaining positive infections of *Phomopsis juniperovora* on potted saplings of the Coast form of Douglas-fir upon which it was quite pathogenic. The Cupressaceous parasite therefore must be considered a potential enemy of this form of Douglasfir, although to date the fungus is not known to occur on it naturally. Reisolates of the cedar-blight organism from infected Douglas-fir produced cultural characters identical with those exhibited by isolates of the fungus used as inocula, which were obtained from diseased stock of eastern red cedar and from that of Italian, Arizona, and Hinoki cypresses.

Cedar blight was first known as a destructive nursery parasite of eastern red cedar in Iowa (**15**). During the first two decades of the 20th century when the propagation and cultivation of ornamental conifers was on the increase in this country, the disease also was reported extremely serious on red cedar in commercial nurseries of States in the same region (6, Map). Since 1920 reports of the disease in nurseries of States of the eastern section of United States have accumulated but records of it in certain of them are meagre or lacking, and some of them are very recent. So far as is known to the writer, cedar blight has not been re-

ported in northern New England (Vermont, New Hampshire, Maine) or in the Southeast in South Carolina, Georgia, Florida and Mississippi. Very little is known about the disease in Louisiana. In the western section of the United States the nursery disease is known only in Nebraska, Kansas, and Oklahoma (recent reports) ; its occurrence in the Dakotas and Texas is problematical (6, 8).

The writer has not studied material of *Phomopsis juniperovora* from the continent of Europe where it has long been suspected and has now been reported to occur as a pathogen on *Juniperus* and *Thuja* nursery stock (16, 17). As in the case of *P. occulta,* its perfect (*Diaporthe*) stage, unknown in this country, may be present in Europe where it may occur on some obscure European host. There is also the consideration that *P. juniperovora* may be mutant, propagating itself only in the imperfect stage.

In this country not a great deal of information is available concerning the occurrence of *Phomopsis juniperovora* as an endemic parasite on mature trees and reproduction of *Juniperus virginiana* throughout the natural range (12, p. 63) of the native host species. During the early period of the cedar-blight investigation the writer searched unsuccessfully for the nursery parasite on native trees in the East in the vicinity of the District of Columbia where the disease and fructifications of the causal organism could be found readily on transplant nursery stock used for ornamental purposes. Within recent years subsequent studies of diseased wildling material from the Central States, particularly from southern Wisconsin not far from Iowa, where the blight has been destructive in nurseries for many years (15) failed to reveal the parasite although other fungi were present.

In 1939 Davis and Latham (1) reported the presence of *Phomopsis juniperovora* on diseased red cedar wildlings growing in North Carolina, Virginia, and Tennessee. They did not find fructifications of the parasite on this type of stock but were able to demonstrate its presence by tissue isolations, which in turn produced the imperfect stage.

During May of the current year the writer was afforded an opportunity to make a study of cedar blight in the Prairie States. In company with Dr. Wright, a brief but intensive search for the
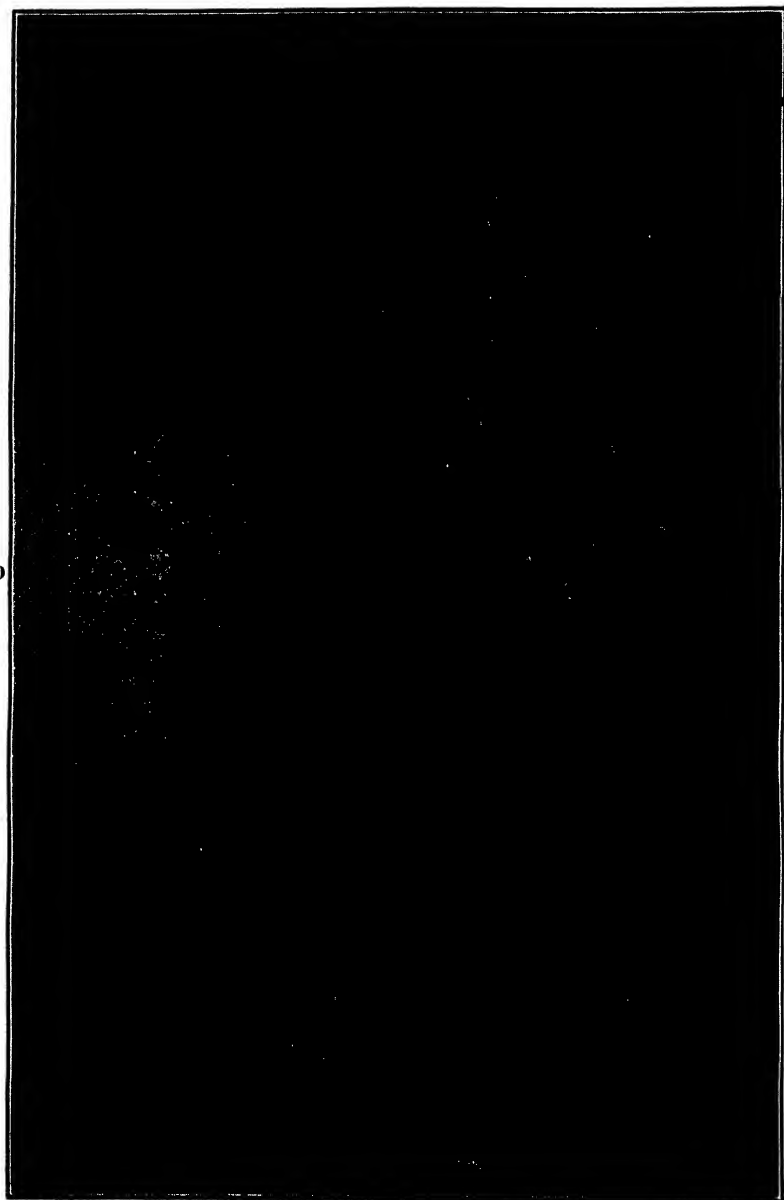
FIG. 2. The forked eastern red cedar wildling was tested on the right with *Phomopsis juniperovora* and similarly on the left with *P. occulta.* Only the tests with the cedar-blight pathogen succeeded. The infected incisions and check below are indicated by arrows. (Photographed by H. G. Eno, March 1942.)

parasite was made on cedars growing in native stands in regions where Federal nurseries troubled with the disease are located at Fremont, Nebraska and Manhattan, Kansas. In the time available for the study, *Phomopsis juniperovora* was discovered only in the Nebraska area, 7 miles from Fremont where cedar blight has been destructive in commercial and Federal nurseries during epidemic years at least since 1915 (6, p. 52). Here the nursery parasite was found on suppressed cedars that were growing in a damp situation in the Platte River bottom beneath a dense closed canopy of mixed hardwoods.

Fruiting bodies of *Phomopsis juniperovora,* the identity of which was proven by cultural tests, are reported on wildling red cedar for the first time. Not a large amount of the parasite was present and that which was found was located with difficulty on weathered, dead branchlet tips of old, suppressed cedars along with other microfungi. In the laboratory these pycnidia under moist conditions produced spore tendrils.

Dr. Wright and the writer were unable to find the pathogen in this same area, which is a source of seed for nursery propagation, on vigorous cedars growing in the open, or on trees or reproduction of all age classes including seedlings growing beneath cottonwoods. Although *Phomopsis juniperovora* was not found on the seed trees in the open, a conspicuous dying of twigs and small branches not caused by *Phomopsis* was very common.

In contrast with the meager amount of fruiting of *Phomopsis juniperovora* on wildlings in the Nebraska area just described, the collectors found abundant fruiting of the parasite on blighted branchlets of nursery cedars used as hedge plants in a Manhattan, Kansas nursery. Isolates from this nursery material were identical culturally with those taken from wildling specimens.

Although it is known that cedar blight has been disseminated on infected nursery stock, further information on the fruiting of the pathogen on wildling cedars is highly desirable in order that our knowledge of its natural distribution may be increased. Data should also be obtained on the problem of whether cedar blight is seed borne. Moreover our knowledge of red cedars highly resistant to the blight also should be increased. The solution of these problems has practical value in the control of the disease, particu-

larly in regions where *Phomopsis juniperovora* has not been reported and where there is a possibility of its nonoccurrence.

SUMMARY

Because of the close morphological similarity between the saprophyte, *Phomopsis occulta* (Trav.) Sacc., and the destructive nursery parasite, *P. juniperovora* Hahn, on eastern red cedar (*Juniperus virginiana* L.), the distribution of the latter as a possible endemic pathogen has been confused, particularly in cases where diagnoses of *Phomopsis* on wildling cedars are concerned.

Comparable wound inoculation tests carried on in an unheated greenhouse with monospore cultures of *Phomopsis occulta* and *P. juniperovora,* the latter serving as a "check" to establish the suitability of the environmental conditions, demonstrated that *P. occulta* was unable to attack any of the 14 wildling eastern red cedar saplings used for the tests. The *P. occulta* inocula were obtained from both wildling and nursery stock. Results of these tests corroborate similar ones obtained previously with *P. occulta* on Arizona cypress and Chinese arborvitae.

All of the 7 red cedars inoculated with *Phomopsis juniperovora* became infected. Three of the wildlings, which were bluish-green in color, were girdled and killed back toward the base of the plant, whereas two saplings, which were decidedly green in color, showed blight resistance. Infections on one of the latter, which was lighter and brighter in color, were confined to nongirdling cankers on the trunk, and the terminal and lateral branches did not show discoloration.

Reisolations of *P. juniperovora* on synthetic malt agar produced the yellow coloration and flaming orange crystals first reported in 1917. These characters are typical of the growth of the pathogen on a number of media. Neither the yellow color nor crystals appear in cultures of *P. occulta,* and they serve to differentiate distinctly the two *Phomopsis* species, the spore size ranges of which overlap.

In a discussion of the two related *Phomopsis* species it is pointed out that the results obtained by the writer in earlier studies demonstrated that *Phomopsis occulta* could be distinguished morphologically from *P. juniperovora,* that *P. occulta* is distributed widely

on conifers both in western Europe and throughout North America on numerous host genera, and that *Diaporthae* on conifers, including the perfect stage, *Diaporthe conorum* (Desm.) Niessl, of *P. occulta,* although common tin Europe, are exceedingly rare in the Western Hemisphere.

Unpublished data are given on experiments conducted in Great Britain during 1926 to 1929, in which the perfect stage, *Diaporthe conorum,* was obtained culturally on twigs of English elm (*Ulmus procera* Salisb.) from monopycnidiospores of the fungus originally isolated from cultures of monoascospores of *D. conorum* collected on Douglas-fir. These results tend to support Wehmeyer's treatment of a large *Diaporthae* complex on both hard and soft woods belonging to the type species, *Diaporthe eres* Nit. on *Acer,* although admittedly, the homothallic *D. conorum* holds priority.

Phomopsis occulta is to be regarded as a secondary fungus on cedars following injury by other factors. Previous studies carried on by the writer showed that under artificial conditions the organism at most was weakly parasitic on the coast form of Douglas-fir.

The pathogen, *Phomopsis juniperovora,* under natural conditions parasitizes only genera of the Cupressaceae. Its *Diaporthe* stage is unknown. A revised host list is given, which includes all of the host species known to be attacked up to the present time. Early studies by the writer demonstrated that under artificial conditions saplings of Douglas-fir, Coast form, were highly susceptible to *P. juniperovora.* Although nursery stock of Douglas-fir is not known to be attacked naturally by the cedar-blight parasite, the potentialities of *P. juniperovora* on juvenile stock of this host merit consideration.

Phomopsis juniperovora is reported to occur in Europe as a nursery parasite on the continent. As in the case of *P. occulta,* its perfect stage (*Diaporthe*) may be present, and there is the possibility that it may be discovered eventually on some obscure European host.

Although we have considerable information on the distribution of the cedar-blight parasite in commercial and Federal nurseries in this country, there is not a great amount of data available concerning the occurrence of the organism on trees and reproduction of

eastern red cedar in native stands. A small amount of fruiting bodies of *Phomopsis juniperovora* collected by Dr. Wright and the writer on suppressed red cedar wildlings, was confirmed later by culture tests and is reported for the first time.

Additional information on the occurrence of *Phomopsis juniperovora* on wildlings is highly desirable from the standpoint of increasing our knowledge concerning the dissemination of cedar blight. In regions where cedar blight has not been reported and where there is a possibility of its nonoccurrence, this information should prove of practical value in disease control.

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LITERATURE CITED

1. **Davis, W. C. & D. H. Latham.** Cedar blight on wilding and forest tree nursery stock. Phytopath. **29**: 991–992. 1939.
2. **Dodge, B. O.** Notes on three hemlock fungi. Mycologia 24: 421–430. *illus.* 1932.
3. **Hahn, G. G.** *Phomopsis juniperovora*, a new species causing blight of nursery cedars. Phytopath. **10**: 249–253. *illus.* 1920.
4. ———. *Phomopsis juniperovora* and closely related strains on conifers. Phytopath. **16**: 899–914. *illus.* 1926.
5. ———. Life-history studies of the species of *Phomopsis* occurring on conifers. Part I. Trans. Brit. Mycol. Soc. **15**: 32–93. *illus.* 1930.
6. ———. Distribution and hosts of cedar blight in the United States. Plant Disease Reporter **24**: 52–57. *illus.* 1940.
7. ———. Reports of cedar blight in 1939. Plant Disease Reporter **24**: 57–58. 1940.
8. ———. Reports of cedar blight in 1940 and notes on its previous occurrence in nurseries. Plant Disease Reporter **25**: 186–190. 1941.
9. ———, C. Hartley & R. G. Pierce. A nursery blight of cedars. Jour. Agr. Res. **10**: 533–540. *illus.* 1917.
10. **Hartley, C.** The blights of coniferous nursery stock. U. S. Dept. Agr. Bull. 44. 21 pp. 1913.
11. **Hepting, G. H. & E. R. Toole.** The hemlock rust caused by *Melampsora farlowii*. Phytopath. **29**: 463–473. *illus.* 1939.
12. **Munns, E. N.** The distribution of important forest trees of the United States. U. S. Dept. Agr. Misc. Publ. 287. 176 pp. *illus.* 1938.
13. **Rehder, A.** Manual of cultivated trees and shrubs. 996 pp. Second Edition. The Macmillan Company, New York. 1940.
14. **Seymour, A. B.** Host index of the fungi of North America. 732 pp. Harvard University Press, Cambridge, Mass. 1929.

15. **Stewart, F. C.** The *Phoma* blight of red cedar. (Note) Phytopath. **8**: 33–34. 1918.

16. **Van Poeteren, N.** Verslag over de werkzaamheden van den Planten-ziektenkundigen Dienst in het jaar 1930. Versl. en Meded. Plant-enziektenkund. Dienst Wageningen 64, 189 pp. *illus.* 1931. (Review in R. A. M. **11**: 95–96. 1932.)

17. ——. Verslag over de werkzaamheden van den Plantenziektenkund-igen Dienst in het jaar 1935. Versl. Plantenziektenkund. Dienst Wageningen, 83, 88 pp. *illus.* 1936. (Review in R. A. M. **16**: 299–300. 1937.)

18. **Wehmeyer, L. E.** The genus *Diaporthe* Nitschke and its segregates. Univ. Mich. Studies. Scientific Series 9. 349 pp. *illus.* 1933.

19. **White, R. P.** Juniper blight. Ann. Rep. New Jersey Agr. Exp. Sta. **50**(1928–1929): 270–272. 1929.

NOTES AND BRIEF ARTICLES

CORRECTION

In paging the article "Some species of *Papulaspora* associated with rots of *Gladiolus* bulbs" by H. H. Hotson in the July–August, 1942 number of MYCOLOGIA, the first line of the second paragraph was accidentally dropped out by the printers. This has been corrected in the reprints but, unfortunately, cannot be changed in the issues which have been sent out. Therefore, please supply in its proper place on page 391, the following line:

"The material used was derived chiefly from .diseased *Gladiolus*"

A LITTLE KNOWN FUNGUS

During a recent vacation trip to Bar Harbor, Maine, among other things, a large *Hydnum* was collected in spruce woods which attracted the writer's attention. On returning home it was identified as *Hydnum boreale,* described by Howard J. Banker in 1902 (Bull. Torrey Club **29**: 253.) from material collected at Bar Harbor in 1901 by V. S. White, and the type specimen deposited in the Garden herbarium. So far as can be discovered no specimen of this species, at least under this name, is preserved in any other herbarium. Two large specimens were obtained and a number of smaller ones, apparently young plants. In fact, I have reason to believe that the species is quite common on Mt. Desert Island and, doubtless, in other localities as well. We believe the species is sufficiently unusual to deserve mention at. this time.—FRED J. SEAVER.

MYCETOZOA: A NEW COMBINATION

I propose to include in the genus *Perichaena* of the Mycetozoa the two following forms heretofore in the genus *Hemitrichia*.

Perichaena minor (G. Lister) Hagelstein, comb. nov. (*Hemitrichia minor* G. Lister, Jour. Bot. 49: 62. 1911) ; and **Perichaena**

minor (G. Lister) Hagelstein, var. **pardina** (Minakata) Hagelstein, comb. nov. (*Hemitrichia minor* G. Lister, var. *pardina* Minakata; G. Lister, Trans. Brit. Myc. Soc. **5**: 82. 1914).

The forms were placed in the genus *Hemitrichia* by Miss Lister, apparently in the belief that the faint, narrow, diagonal lines appearing occasionally on the threads of the capillitium were thickened, spiral bands, as found in that genus. A critical examination with an apochromatic objective of N. A. 1.4 of the capillitium of a fine collection of the two forms from Long Island, New York, shows that these apparent lines are not thickened, spiral bands, but merely the appearance of the arrangement, here and there, of minute spines on the threads, similar to the oblique markings seen on the siliceous valves of many species of the Diatomaceae, which latter are composed of minute puncta. In all other respects the characters of the two forms are those of the genus *Perichaena*.— ROBERT HAGELSTEIN.

WYNNEA AMERICANA IN WESTERN PENNSYLVANIA

While collecting fungi, 3 miles N.E. of Emlenton, Venango County, Pennsylvania, in September 1942, the writer found a small clump of *Wynnea americana*. This region is over 100 miles north of Pennsylvania's southern border. According to previously published records, this seems to be the northernmost range for this species.

In 1936 and again in 1937, the writer collected specimens from two localities, about two miles apart, 4 miles N.E. of Harmony, Butler County, Pennsylvania. These localities are in approximately the same latitude as Mansfield, Ohio, where specimens had already been reported.

The Carnegie Museum Herbarium has several other collections of this species, chiefly from the southern mountainous section. O. E. Jennings collected specimens at Ohio Pyle, Fayette County, Pennsylvania in 1905. These were noted and described by D. R. Sumstine in the Journal of Mycology (**12**: 59. March, 1906). In 1906 and 1907 additional specimens were obtained from the Ohio Pyle region and also from New Florence in northeastern Westmoreland County, Pennsylvania. These were reported in the

Annals of Carnegie Museum (Vol. IV, Nos. III & IV, April, 1908).   D. R. Sumstine collected specimens at Idlewild Park near Ligonier in 1910 and at Jones Mills in 1936, both localities in Westmoreland County.   In 1922 specimens were found by O. E. Jennings near Rector, Westmoreland County, and in 1932 by C. M. Hepner near Trent, Somerset County, Pennsylvania.—L. K. HENRY.
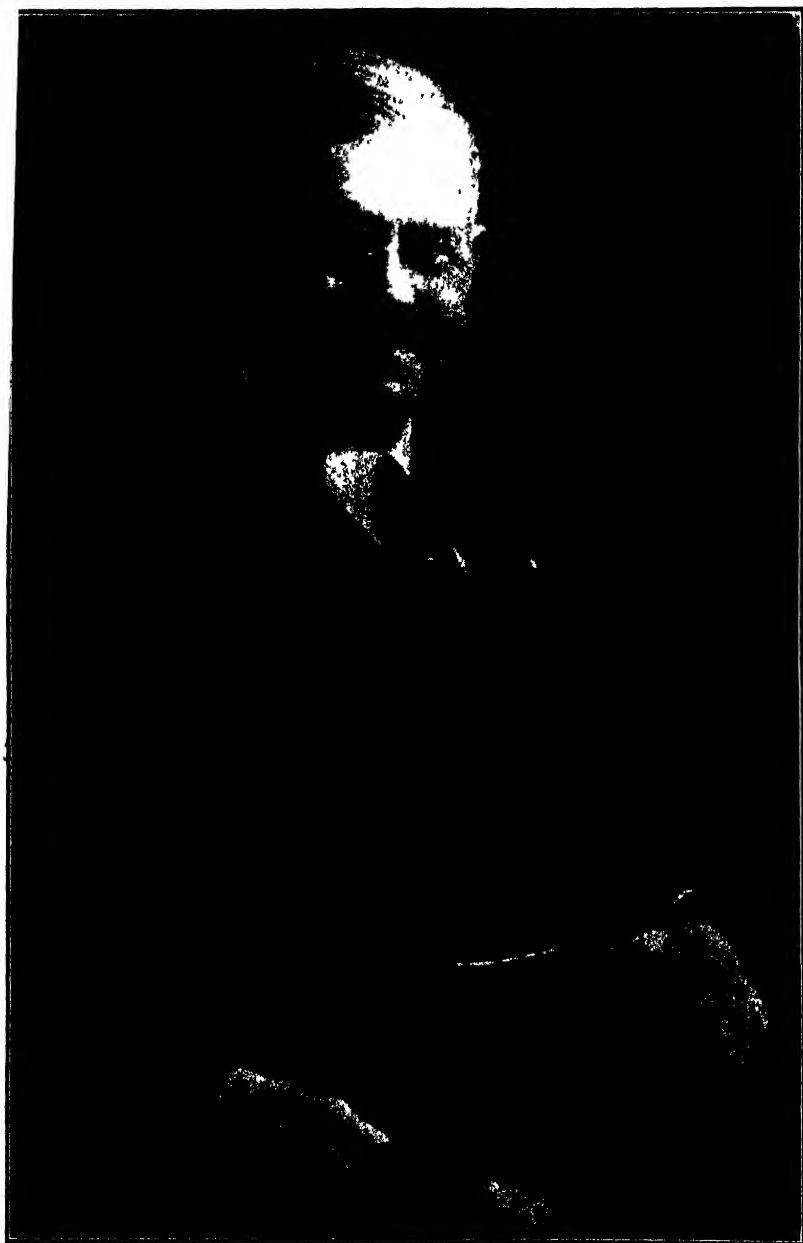
WILLIAM STURGIS THOMAS.

WILLIAM STURGIS THOMAS

FRED J. SEAVER

(WITH PORTRAIT)

One of the recent losses among the members of the Mycological Society of America was Dr. William Sturgis Thomas, who passed away on December 21, 1941. While a physician by vocation, he was a mycologist or a mycophagist by avocation, and his name is doubtless well known to mycologists through the publication of "Field Book of Common Gilled Mushrooms," the first edition of which was published in 1928, a second edition appearing in 1936 under the title "Field Book of Common Mushrooms."

Dr. Thomas was a physician of some note and occupied many prominent positions during his life-time. A full account of these activities appears in the Journal of the New York Botanical Garden for January, 1942. He was a member of the Mycological Society of America from the beginning, and was very active in the organization of the local New York Mycological Society, having been President of that organization up to the time of his death. In this connection he conducted many field trips and was always an inspiration to the large group of amateur mycologists with whom he was associated.

It was the writer's privilege to know him over a long period of years and to have had him as guest in our home. Besides Mrs. Thomas he is survived by a daughter, Mrs. A. T. Jersild, and a son, William Stephen Thomas, who has recently entered the United States Navy.

NEW YORK BOTANICAL GARDEN

A NEW NON-HELICOID BISPOROUS HELI-COCEPHALUM PARASITIZING NEMATODE EGGS

CHARLES DRECHSLER

(WITH 1 FIGURE)

More than half a century ago Thaxter (4), then stationed at New Haven, Conn., erected the genus *Helicocephalum* on a curious fungus he described under the name *H. sarcophilum* after discovering it on carrion in a laboratory culture. The fungus was set forth as having the general habit of a large *Mortierella* or *Syncephalis,* its aseptate or rarely septate hyaline mycelium creeping over the substratum and giving rise here and there to tall, erect, continuous, unbranched, gradually tapering, hyaline sporophores supported at the base by rhizoid-like attachments. If the vegetative mycelium and the columnar portion of the sporophore offered little that could be held unusual, the distal portion of the sporophore not only presented remarkable external differentiation in widening out and coiling abruptly two or three times, but also displayed noteworthy internal development by undergoing segmentation into a chain of large, dark brown conidia, which after their disarticulation cohered in a rounded mass.

Spiral coiling in the terminal portion of the sporophore and subsequent segmentation of the helicoid part into a chain of spores which after their disarticulation remain attached in a cohering cluster likewise marked the reproductive development of an obviously congeneric fungus that came to my attention ten years ago in an old agar plate culture originally planted with decaying spinach (*Spinacia oleracea* L.) roots from southeastern Virginia. This species I described as *Helicocephalum oligosporum* (1) since it produced commonly 5 to 10 (rarely 11) spores in a head, whereas the Connecticut form had been found bearing as many as 21 spores, seldom more, on the individual fertile hyphae. Besides being produced in lesser numbers, the conidia of *H. oligosporum* were

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smaller, measuring mostly 32 to 45 μ in length and 20 to 25 μ in width as compared with a length of 55 μ (maximum 65 μ) and a width of 30 μ (maximum 35 μ) attributed to the spores of *H. sarcophilum*. The sporophores bearing these smaller spores measured only 350 to 600 μ in height and 13 to 16 μ in basal width, as compared with a height of 1 mm. or more and a basal width of 20 to 25 μ recorded by Thaxter. Commensurate with the less robust proportions of its reproductive apparatus my fungus had a more delicate mycelium, its vegetative hyphae measuring only 1 to 1.3 μ in width, as against a hyphal width of 2 μ in *H. sarcophilum*.

A fungus in many ways closely resembling *Helicocephalum sarcophilum* and *H. oligosporum* came to light in several maizemeal-agar plate cultures that after being permeated with mycelium of *Pythium mamillatum* Meurs had received some little addition of partly decayed bluegrass (*Poa pratensis* L.) leaves removed on May 10, 1941, from a heap of old lawn clippings in Arlington, Va. Its conidiophores, somewhat more slender but evidently no less tall than those of Thaxter's fungus, began to appear about a week after the decaying material had been added. Day after day for a period of more than three weeks, during which the temperature of the laboratory varied between 28° and 32° C., new sporophores came up in scattered positions. Eventually the empty membranous remains of old sporophores could be found sparsely distributed here and there in nearly all portions of each culture.

When examined under a microscope of sufficiently high magnification, preferably at a somewhat early stage of development, the individual sporophore was found anchored to the agar substratum by frequently more than a dozen rhizoidal outgrowths extending away in different directions (FIG. 1, *A; B, b; C, b; D, d*). These outgrowths seemed to function only in giving support, for very soon after attaining definitive length they lost their granular contents to persist as empty tubular membranes. A single filamentous branch, less conspicuous than the rhizoidal outgrowths and often only 25 to 50 μ in length, was always found connecting the slightly swollen base of the sporophore with the vegetative mycelium (FIG. 1, *A; B, c; C, c; D, e*). This unpretentious branch represented, of course, the hyphal element from which the entire unit of reproductive apparatus originated, and through which it necessarily had

to receive all its protoplasmic materials.   With respect to width the communicating branch and all other mycelial hyphae that likewise remained visible for a long time were coarser than the corresponding filamentous elements of *Helicocephalum oligosporum,* but more delicate than the sterile hyphae of *H. sarcophilum.*   Nowhere in the vegetative mycelium were cross-walls found separating masses of protoplasm, though retaining walls were often observed delimiting a portion of living hypha from a contiguous empty portion. In view of the strictly unseptate character of its living mycelium, the fungus must be reckoned among the Phycomycetes no less unreservedly than *H. oligosporum.*

When fully grown the sporophore tapered upward very gradually, often for a distance of about 1 mm., and then widened rather abruptly to form an elongated head that usually came to show a broad, somewhat gradual constriction midway toward the rounded apex (FIG. 1, *A; B, a*).   As a rule the head was entirely straight, its axis prolonging that of the supporting columnar shaft (FIG. 2, *A; B, a*) ; though occasionally some slight curvature was noticeable (FIG. 1, *C, a*).   This meager and infrequent curvature may readily have been due to some chance inequality in the pull eventuating from the surface tension of a droplet of clear watery liquid that at an early stage would begin accumulating around the head, especially below the median constriction (FIG. 1, *A; C, a*). · With continued extrusion of watery liquid this adhering droplet grew often to a diameter of 100 μ, while simultaneously the elongate head, through insertion of two partitions, one near the base and the other at the constriction, was converted into two spores in end-to-end arrangement.   On becoming disarticulated, these spores, now deep brown in color and prolate ellipsoidal in shape, were coerced by the surrounding droplet into a new positional arrangement making them longitudinally parallel and laterally contiguous with one another as well as with the upper portion of the sporophore (FIG. 1, *D, a, b, c*).

As disarticulation inevitably entailed circular rupture of the peripheral membranous layer that originally constituted the sporophore wall (FIG. 1, *E*), the spore of distal origin was found marked at its proximal end by an annular flange-like thickening which appeared in profile as a slight external irregularity.   The spore of proximal origin bore a flange-like thickening of similar compass at

its distal end; while at its basal end it was marked by annular thickening of lesser compass (FIG. 1, *E*).   In the side-by-side arrangement of the two spores lengthwise along the distal portion of the sporophore (FIG. 1, *D, a; F, a*) the one of proximal origin (FIG. 1, *D, b; F, b*) was usually, though not invariably, found inverted; while the one of distal origin (FIG. 1, *D, c; F, c*) was commonly found in normal posture, with its distal end—the end distinguished by absence of any irregularity in the outer contour of the wall—directed upward.   Generally the two spores of a pair were approximately equal in size, yet now and then instances came under observation where one spore was fully a third larger than its mate (FIG. 1, *F, b, c; G, H*).

After remaining erect for perhaps a week the aging sporophores usually fell over, bringing the twin spores into contact with the moist substratum.   Germination then often ensued within a few days, usually as in *Helicocephalum oligosporum* by the production of a single germ hypha (FIG. 1, *I*).   This single hypha always emerged from a portion of wall laid down as a delimiting septum, never from the more extensive portion of spore wall representing the membrane that originally enveloped the fertile head of the sporophore.   Within the circular area laid bare at the time of disarticulation emergence most often was from a peripheral position close to the flange-like modification.   By using up the large supply of finely granular protoplasm in the massive spore the germ hypha soon developed into a rather extensive mycelium consisting for the most part of sparingly branched, submerged or prostrate, colorless filaments, 1.5 to 1.9 μ wide,—of filaments, therefore, quite like those making up the mycelium that gave rise to sporophores. However, the younger mycelium could be seen bearing here and there fairly long branches only .7 μ or .8 μ or .9 μ wide, which had no visible counterpart in any mycelium old enough for reproduction.   When one of these branches encountered a nematode egg it would give rise, often laterally, to a swollen appressorium that after penetrating the echinulate egg integument introduced an elaborate haustorium composed of handsomely flexuous hyphal elements mostly 2 to 2.7 μ wide (FIG. 1, *J*).   Once the haustorium had completely assimilated the materials within the egg, its own

protoplasmic contents were withdrawn backward into the delicate branch, which, from continued retreat of the protoplasm into the wider parent filament, was in turn evacuated, and as a result became indiscernible to ordinary microscopical examination. The delicate branches appeared to constitute a somewhat specialized apparatus whereby the fungus was enabled, with frugal expenditure of its substance, to seek out nematode eggs widely scattered through an extensive mass of substratum. In their exploratory function and early evanescence they resembled the similarly slender branches by means of which the hyphomycete I recently described as *Trichothecium arrhenopum* seeks out and destroys *Pythium* oöspores (3).

The fungus appears remarkable especially for the dimensional extremes found combined in it. For while its exploratory branches are so narrow that they invite comparison with the vegetative filaments of *Actinomyces,* and with the mycelial hyphae of such minute Zoöpagaceae as *Acaulopage rhaphidospora* Drechsl. (2) and *Stylopage lepte* Drechsl. (2), its unicellular spores, fully twice as voluminous as those of *Helicocephalum sarcophilum,* are perhaps the largest aerial asexual spores produced by any phycomycete now known. Apart from the slenderness of its exploratory branches, and the unseptate character of its mycelium, it offers some little parallelism with *Actinomyces* and with several genera of the Zoöpagaceae—the genera *Zoopage, Cochlonema,* and *Bdellospora*—in its catenulate sporulation. This parallelism reaches fuller expression in *H. sarcophilum* and *H. oligosporum,* since these species produce their spores in longer chains which previous to disarticulation are spirally coiled like the spore chains in numerous species of *Actinomyces.*

Although Thaxter's diagnosis of *Helicocephalum* specifies fertile hyphae "spirally coiled at the apex," the fungus parasitizing nematode eggs resembles the helicoid forms so closely in all essential respects that no reasonable doubt can be entertained as to its intimate kinship with them. I am therefore referring it to the same genus, despite its failure to display the remarkable feature signalized in the generic name.
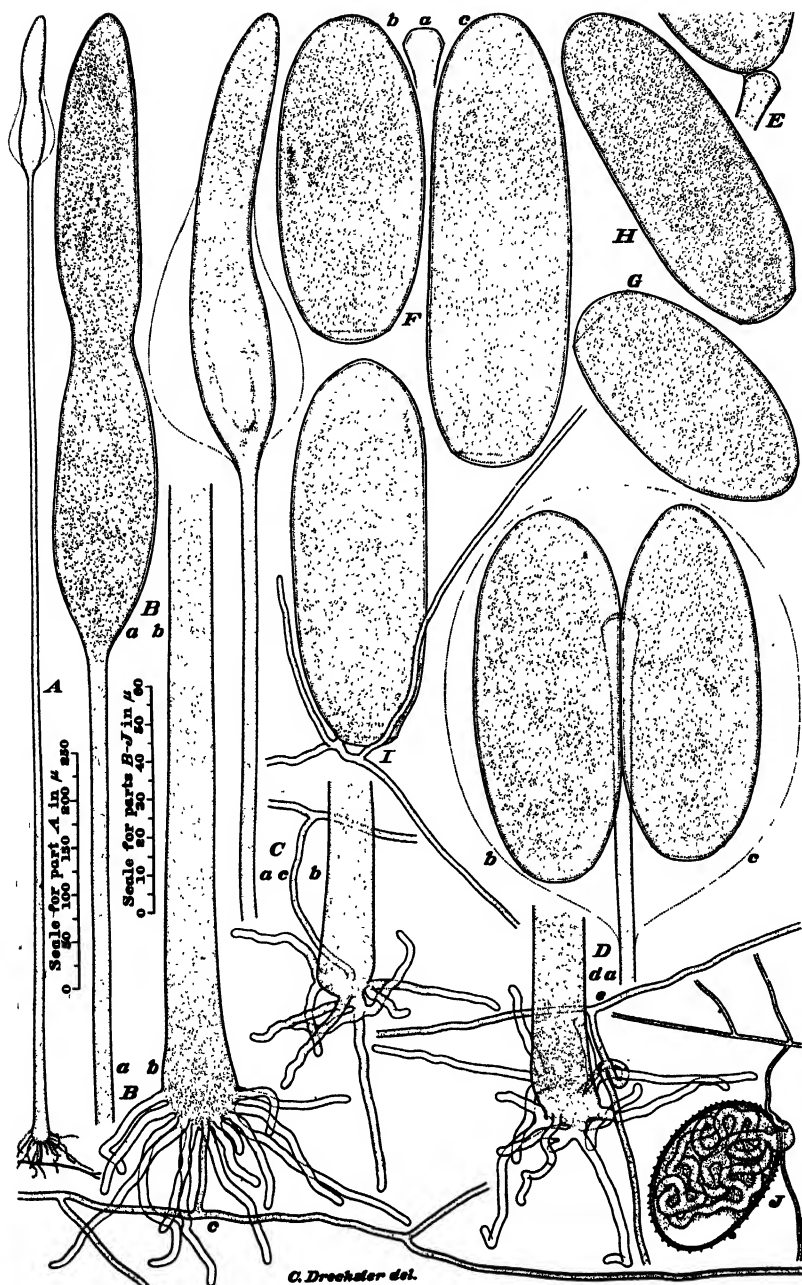
Fig. 1. *Helicocephalum diplosporum.*

Helicocephalum diplosporum sp. nov.

Mycelium parcum, hyalinum, continuum, parve ramosum, in hyphis viva-cioribus plerumque 1.5–1.9 μ crassis et ramulis evanidis vulgo .7–.9 μ crassis constans; his tenuibus ramulis in ovum vermiculi nematoidei incasis, appressorium saepius circa 6 μ latum ei applicantibus, putamen eius perforantibus, haustorium intrudentibus; haustorio ramoso, ex filis flexuosis 2–2.7 μ crassis constante. Hyphae fertiles columnares, erectae, continuae, magnam partem hyalinae, 8–20 ramis radiciformibus 10–60 μ longis 2–2.5 μ crassis sustentatae, basi plerumque 14–20 μ crassae, sursum tenuatae, prope apicem 3.5–5.5 μ crassae, capite denuo latescentes etiam fuscescentes, ibi duas sporas in cate-nulam rectam (numquam in spiram) gignentes, quae postea, catenula diffissa, ad partem superam hyphae fertilis in longitudinem haerent; sporis fulvis, elongato-ellipsoideis, plerumque 70–130 μ longis, 34–39 μ crassis, membrana .5–1 μ (magna parte circa .6 μ) crassa circumdatis.

Ova vermiculi nematoidei interficiens consumensque habitat in foliis *Poae pratensis* putrescentibus in Arlington, Virginia.

Mycelium scanty, colorless, continuous, sparingly branched, consisting of rather long-lived hyphae mostly 1.5 to 1.9 μ wide and of more evanescent branches commonly .7 to .9 μ wide; the narrow branches on encountering a nematode egg producing in contact with it an appressorium, often about 6 μ wide, that perforates the egg integument and intrudes a haustorium composed of flexuous assimilative filaments 2 to 2.7 μ wide. Fertile hyphae columnar, erect, continuous, for the most part colorless, supported below by 8 to 20 rhizoidal branches mostly 10 to 60 μ long and 2 to 2.5 μ wide, above the slightly swollen base 14 to 20 μ in diameter tapering gradually upward to a width of 3.5 to 5.5 μ before widening out into a brownish, elongated, medially constricted, straight or nearly straight, terminal head, which through deposition of two transverse partitions is converted into two spores that after disarticulation adhere lengthwise to the upper portion of the erect column, immersed for some time in a droplet of clear watery liquid; spores brown, elongate ellipsoidal, mostly 70 to 130 μ long, 34 to 39 μ wide, surrounded individually by a wall .5 to 1 μ (mostly about .6 μ) thick.

Destroying and consuming nematode eggs it occurs in decaying leaves of *Poa pratensis* in Arlington, Va.

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LITERATURE CITED

1. **Drechsler, C.** A new species of *Helicocephalum.* Mycologia **26**: 33–37. 1934.
2. ——. Some non-catenulate conidial Phycomycetes preying on terricolous *Amoebae.* Mycologia **27**: 176–205. 1935.
3. ——. Another hyphomycetous fungus parasitic on *Pythium* oöspores. Phytopathology **33**: 1943.
4. **Thaxter, R.** On certain new or peculiar North American Hyphomycetes. II. Bot. Gaz. **16**: 201–205. 1891.

EXPLANATION OF FIGURE

FIG. 1. *Helicocephalum diplosporum,* drawn with the aid of a camera lucida; all parts except *A* shown at a magnification of 500 diameters. *A,* Full grown, immature sporophore with lower portion of terminal head surrounded by a droplet of watery liquid; × 125. *B,* Portions of the same sporophore shown at a magnification four times greater: *a,* upper portion, showing the slender proximal attachment and median constriction of the terminal head, the outline of the adhering droplet being omitted; *b,* lower portion, showing distribution of the rhizoidal branches about the slightly bulbous base, and connection of the basal part with the mycelial filament *c.* *C,* Portions of a sporophore almost fully grown: *a,* upper portion, showing slender attachment and slight median constriction of terminal head, as well as envelopment of the wider proximal part of the head in a droplet of watery liquid; *b,* lower portion, showing distribution of rhizoidal branches about the slightly expanded base; *c,* mycelial branch connecting sporophore with the mycelium. *D,* Portions of a fully mature sporophore: *a,* terminal portion to which are adhering the inverted proximal spore *b* and the distal spore *c* with its apex directed upward; both spores being surrounded by a droplet of watery liquid; *d,* expanded basal portion of sporophore, showing its supporting rhizoidal branches as well as the hypha connecting it to the mycelial filament *c.* *E,* Basal portion of proximal spore and tip of mature sporophore, showing manner of disarticulation. *F,* Expanded tip of mature sporophore *a,* flanked by the two spores, *b* and *c,* in usual arrangement,— the proximal spore *b* inverted, the exceptionally long terminal spore *c* in normal posture, with apex directed upward. *G,* An exceptionally short spore of proximal origin. *H,* Spore of average dimensions formed terminally in the same head as *G.* *I,* Spore of proximal origin germinating from its distal end. *J,* Slender exploratory branch with an appressorium from which a haustorium has grown into a nematode egg.

TYPE STUDIES ON BASIDIOMYCETES. II [1]

R. Singer [2]

The purpose of the following type studies on Basidiomycetes, especially agarics and boletes, has been explained in another paper devoted to the same kind of studies and recently published in Lloydia **5**: 97. 1942. The present series of type studies concerns more especially collections preserved at the N. Y. State Museum, Albany, N. Y., where are located the numerous and extremely important types of Peck's species, described mostly from New York State.

The author is indebted to Dr. Homer D. House of the N. Y. State Museum of Natural History, Albany, who placed the material at his disposal. Some specimens which have been studied at the Farlow Herbarium have been made available through the kindness of Dr. David H. Linder.

RUSSULACEAE

RUSSULA MAGNIFICA Peck, Bull. N. Y. State Mus. **67**: 24. 1903.
> Part of type preserved at New York Botanical Garden, another part at New York State Museum. ·

Spores 7.5–10.3 × 6.2–8 μ, ornamentation type IIIa–VII, or IIIb–VII, more rarely IV–VII, up to 0.3 μ high, hyaline in NH_4OH, asymmetrical. *Cystidia* very numerous, with abundant granular or banded contents, fusoid, with acute or blunt apex or somewhat bottle-shaped, 68–100 × 7–16.5 μ. *Surface of the pileus* consisting of irregularly interwoven hyaline, thin-walled hyphae of 2–3 μ diameter; among them rather numerous laticiferous hyphae are found, some of them having the shape of dermatocystidia. *Margin* of the pileus decidedly acute.

Conclusion: Related to the subsection *Delicinae* and probably identical with *Russula polyphylla* Peck:

[1] The first part of Type Studies has been published in Mycologia **34**: 64. 1942.

[2] Contribution from the Laboratories of Cryptogamic Botany and the Farlow Herbarium, Harvard University, no. 218.

Russula polyphylla Peck, Bull. Torrey Club **25**: 370.   1898.
   Type.

Spores 8.5–10.5 × 5.8–8 μ, ornamentation type IIIa–VII, more
rarely IIIb–VII, 0.1–0.3–(0.4) μ high, reticulation extremely faint,
hyaline.   *Cystidia* very numerous with banded contents, mostly
acute, but sometimes also attenuate but obtuse, 48–100 × 7–14 μ.
Surface of the pileus consisting of cylindrical, 4–6.8 μ thick lati-
ciferae with banded, rarely granular contents or contents lacking.

Conclusion: There is every reason to assume that *Russula poly-
phylla* is the same as *R. magnifica*, Peck having redescribed it as
R. magnifica when he was able to collect fresh specimens.   The
description of *Russula polyphylla* apparently was based on dried
material and on notes made by the collector.

Russula compacta Frost & Peck apud Peck, Ann. Rep. N. Y.
   State Mus. **32**: 32.   1880.   Type, and fresh material from
   Purgatory Swamp, Norwood, Mass., compared with the type.

Pileus white, later between "avellaneous" and "cinnamon Buff"
(R.), the cuticle separable on the outer half of the pileus, opaque,
very faintly rimulose, or not, eventually often cracking, umbilicate,
then infundibuliform; *surface of the pileus* consisting of cylindri-
cal, interwoven, hyaline or yellowish, thin-walled hyphae (up to
0.6 μ thick), without any contents and therefore not laticiferous,
2.7–6.7 μ in diameter; diameter of the pileus 75–150 mm.; *lamellae*
milk white, very crowded, arcuate-concave, but broadest in the
outer (marginal) third, rather narrow: 8 mm. broad, very little
anastomosing, very strongly intermixed with lamellulae but not at
all polydymous, many lamellae forked particularly near the stipe,
almost obtuse on the margin (about 90°) when mature, emarginate-
free; becoming dark gray with aniline oil; spore print white (Craw-
shay A); spores from the deposit 7–10 × 6.5–8.3 μ, ornamentation
type IIIa, IIIb, IV (rarely), VIII (exceptionally) 0.3–0.5 μ high.
Cystidia with a strange body in its contents which is rather small
and very well visible in sulfovanilline but becomes only indistinctly
blue in this reagent; subhymenium consisting of cellulae passing
into the well developed hymenopodium, consisting of divergent
normal hyphae; mediostratum cellular with few normal hyphae in-
termixed.   *Stipe* white, thick and cylindrical, with a large cavity
when mature, firm, smooth (not rugulose).   *Context* white, imme-
diately and strongly staining brown when exposed to the air, be-

coming about the same brown as old specimens of *Russula xerampelina;* taste mild; odor of trimethylamine, after a while becoming mixed with a cacodyle-like odor; sulfovanilline becoming chocolate brown (normal reaction); aniline oil: quickly rufous brown; $FeSO_4$: immediately green; formol: no reaction. *Habitat:* In mixed woods, on fairly humid places under frondose and coniferous trees, mostly in summer. Rather frequent.

Conclusions: A comparison of the descriptions of *R. compacta* and *R. polyphylla* (Syn.: *R. magnifica*) would lead to the supposition that the species are identical but a study of the type show them to be distinguishable even by their macroscopical characters by which they may be separated as follows: in *R. compacta* the pileus tends to be fulvous, with blunt margins, and the lamellae become gray on drying, while in *R. polyphylla* the pileus tends to be buff colored, to have conspicuously acute margins, and the lamellae are brownish. The above is supplemented by the writer's previous description (Bull. Soc. Myc. France **54**: 141. 1938). In addition to the type, there is preserved at Albany a specimen collected by Davis in Boston, Mass. that was determined as *R. compacta* but is in reality *R. xerampelina* (Schaeff.) Fries.

RUSSULA ECCENTRICA Peck, Bull. N. Y. State Mus. **150**: 61. 1911. Type.

Only two poorly prepared specimens are preserved; they are the same as Kauffman's plant (compare Singer, Bull. Soc. Myc. France **55**: 227. 1939). The conclusion therefore is the same as for these specimens.

RUSSULA GRANULATA Peck, Ann. Rep. N. Y. State Mus. **53**: 843. 1900. Type.

This is exactly the same as *Russula obtecta* Sing. (Bull. Soc. Myc. France **55**: 234. 1939), which consequently becomes a synonym of *R. granulata*. All descriptive data and commentaries, made on *Russula obtecta,* are valid for *R. granulata*.

RUSSULA FOETENTULA Peck, Bull. N. Y. State Mus. **116**: 85. 1907. Type.

Spores 8.3–10 × 7.3–8.2 μ, ornamentation type IV, more rarely IIIb, V, VI, sometimes II–IV, IV–VIII, the spines distributed irregularly (0.8) 0.9–1.1 (1.4) μ high. *Cystidia* very numerous.

Conclusion: This is *Russula foetens* var. *minor* Sing., Bull. Soc. Myc. France **54**: 135. 1938.

RUSSULA ANOMALA Peck, Ann. Rep. N. Y. State Mus. **50**: 99. 1897. Type.

Spores 9.3–10 × 7.7–8.2 μ, ornamentation type VI, rarely V, spines 0.6–1.2 μ high. *Basidia* 37 × 6.5–7.5 μ, 4-spored. *Cystidia* numerous, very thick, with banded contents, clavate to fusoid, mostly bluntly rounded, 70 × 14–16 μ. *Trama* with numerous spherocysts.

Conclusion: This is a species of the *R. citrina–R. Raoultii–R. albida–R. innocua*-group of *Ingratae,* differing from *R. albida* and *R. inocua* in acrid taste, and from *R. citrina* and *R. Raoultii* in echinulate, not reticulate spores. My previous identification of this species with the white form of *R. emetica* ssp. *fragilis* was a mistake, although Peck's short description permits such an interpretation.

RUSSULA CRUSTOSA Peck, Ann. Rep. N. Y. State Mus. **39**: 41. 1887. Authentic material.

I was not able to identify the type specimen from Day, N. Y. The rather abundant authentic material preserved at Albany is a mixture of different species. A sheet of specimens collected at Port Jefferson belongs to *Russula crustosa* sensu Kauffman (*i.e.* *R. cyanoxantha* var. *variata*), another sheet from Whitehall, N. Y., belongs to a species close to the one described by the writer (Bull. Soc. Myc. France **55**: 240. 1939) as *Russula crustosa* Peck sensu Coker. It is, however, somewhat different from the latter, and therefore the notes on Peck's Whitehall material follows:

Pileus greenish, finally fading to brownish; subcutis consisting of 2–2.8 μ thick hyphae and scattered laticiferae of 3.5–7 μ diameter, epicutis consisting of a pseudoparenchyma; the cells are for example 16 μ in diameter and bear a rather short hair-like proliferation that frequently is septate and about 4 μ in diameter. *Cystidia* with or without contents, 6.5–8.5 μ thick. *Spores* 7–8.5 × 6–7.5 μ,

ornamentation type IIIa (b)–VIII, the warts 0.3 μ high.   *Context* becoming very bright purplish red with sulfonvanilline.

This same species has been collected in Purgatory Swamp, Norwood, Mass., in fresh condition.   The cystidia become almost entirely blue in sulfovanilline, the context becomes orange in $FeSO_4$.

Russula modesta Peck, Bull. N. Y. State Mus. 116: 78.   1907.
    Type.

Spores 6.7–7.3 × 5.8–6 μ, ornamentation IIIb–IV (the larger ones often VI), with very thin connecting lines, and rather dense to scattered up to 0.7 μ high warts.   *Basidia* 26 × 7.5 μ.   *Cystidia* 80 × 9–14 μ, fusoid or subcylindrical, blunt or acute, with abundant banded content.   *Cheilocystidia* scattered along with actual cystidia on the edge of the lamellae, needle shaped or subulate, with 0–2 septa on the very apex which easily breaks off, without contents, 45–55 × 2.5–7.5 μ.   *Epicutis* consisting of scattered clavate 50–95 × 6.5–10.5 μ large dermatocystidia and very numerous hairs with thin to medium thick (0.6–0.8 μ) walls and blunt tips, the base of the hairs originating from a subglobose basal cell, or a series of such cells (9 × 8 μ, 18 × 9 μ, 15 × 10 μ, etc.).   These cells are smaller than they usually are in the *Virescens*-group, but more marked than in the *Vesca*-group.   *Hyphae* of the subcutis thin-walled, long, hyaline, 2–3.5 μ thick.

Conclusion: This species reminds one of *Russula Mariae* as well as of *R. virescens* and even *R. grisea* and *R. furcata*.   *R. modesta* seems to be rather ambiguous between the stirpes of the subsection *Chlorinae* on one hand, and the subsection *Virescentinae* on the other hand.   The material described from the Great Smoky Mountains in 1939 (Bull. Soc. Myc. France 55: 245–246.   1939) very probably belongs to the same species as Peck's original *R. modesta*.

Russula albella Peck, Ann. Rep. N. Y. State Mus. 50: 101.
    1897.   Type.

Spores 7.5–9.3 × 6–6.3 μ, ornamentation type IIIa, more rarely IIIb, the warts 0.5–0.7 μ high, the connecting lines mostly thin.   *Basidia* 34 × 7.5–11.5 μ.   *Cystidia* 55–66 × 9–10 μ, with banded content, fusoid or cylindric-fusoid, or bottle-shaped, the ones on the edge of the lamellae appendiculate, the appendix about 6 μ long.   *Epicutis* with moderately numerous dermatocystidia which are clavate, stuffed with banded content, 65–82 × 4.5–9 μ.

Conclusion: This is a very rare species and not well enough known to make any conclusive statement upon its position. Nevertheless the data furnished from a study of the type should be sufficient for identification of fresh material that finally will help to locate *R. albella.*

RUSSULA PURPURINA Schulzer, sensu Peck, non Schulzer. Authentic material, collected and determined by Peck, compared with fresh material from Newcomb Co., N. Y.

As I have mentioned in an earlier paper (Bull. Soc. Myc. France **55**: 250–250.   1939), *Russula purpurina* of the American authors is not identical with anything found in Europe.   This species has to be renamed.   The following name is proposed:

Russula Peckii Sing. sp. nov. Pileo rubro vel rarius roseo, subviscido, subpruinoso in statu sicco, 35–77 mm. lato. Dermatocystidiis nullis, sed pilis microscopicis numerosis, granulis paucis sulfovanillina ope subnigrescentibus impletis atque hyphis primordialibus numerosis in epicute obviis. Lamellis albis, demum subflavescentibus, aequalibus. Stipite plus minusve concolori. Carne alba, rubella sub cute, miti, inodora, solutione aquatica phenolica ope grisca. Habitatio: Sub coniferis. Observatio: Ad subsectionem *Lepidinae* pertinet. Typus est collectio Peckii primaria, co-typi sunt collectiones posterae (North Elba, N. Y., Piseco, N. Y., etc.).

Fresh material of *R. Peckii* has been studied by the writer and some remarkable features of this beautiful plant are worthy of mention: The reaction with phenol is unique among the agarics, or at least the Russulae.   Phenol stains the context "Benzo brown" to "deep Quaker drab" or "dark purplish grey" or "dark Quaker drab," reaching eventually "Aniline black."   The "amorphous body" in the cystidia, mentioned in my description (l.c.), and also the granulae found in many of the hairs of the epicutis stain blue to blackish blue in sulphovanilline.   Consequently *R. Peckii* is one of the most outstandingly characterized species in *Russula,* anatomically as well as chemically, and should be easily recognized. It always grows under coniferous trees.

RUSSULA LUTEOBASIS Peck, Bull. Torrey Club **31**: 179.   1904. Type.

Spores pale yellowish under the microscope in ammonia, 7.8– 11.3 × 6–9 μ, very variable in a single preparation, ornamentation

type likewise varying: II, IIIa, IIIb, IV, V, VIII, more rarely VII–IX, the warts up to 0.7 μ high. *Basidia* 27–37 × 10–13 μ. *Cystidia* 62 × 6.5–10 μ, with loose banded or granular content, fusoid, not numerous; cheilocystidia without contents, mostly about 41× 4–5.5 μ large and rather versiform. *Epicutis* consisting of long rows of primordial hyphae, the terminal members rounded-blunt and often covered with a yellowish incrustation, sometimes with moderately thickened walls, sometimes one member somewhat bloated, but mostly 3.5–6 μ in diameter.

Conclusion: This remarkable species belongs in the subsection *Olivaceinae,* along with such species as *R. borealis* and *R. pseudo-integra.*

Russula nigrescentipes Peck, Bull. Torrey Club **33**: 214.   1906.
    Type.

Pileus a very bright red but not shining; epicutis consisting of hairs; the hairs arising from a thicker (about 6.5 μ) ovoid basal cell, the terminal member oblong or mostly cylindrical and about 2–4.5 μ thick, some of them somewhat incrusted, some with granular, and some even with banded contents, so forming a transition toward dermatocystidia, though actual dermatocystidia lacking. *Lamellae* somewhat yellowish in dried condition; spores 6.7–9.5 × 5.7–7.5 μ, ornamentation type II, IIIb, more rarely IIIa, IV, II–IV, the warts or ridges 0.3–0.6 μ high, mostly 0.5 μ and rather cylindrical than pyramidal as far as warts are concerned, many spores somewhat yellowish in NH_4OH, almost as much as in *Russula pulchella; basidia* 27–32 × 9.5 μ. *Cystidia* not very distinct. *Stipe* abruptly black at base.

Conclusion: *Russula nigrescentipes* Peck has been placed in the section *Decolorantes,* subsection *Decolorantinae,* by the writer (1926, 1932, 1935). This certainly is the proper position of Peck's species although it is not quite certain that the spores are white, as indicated by its author.

Russula flaviceps Peck, Ann. Rep. N. Y. State Mus. **53**: 843.
    1900.   Type specimens, and authentic material.   ·

The type specimens are not homogenous. One part of them does not agree very well with the original description given by Peck, since it shows reddish hues on the pileus and rather deep

yellow lamellae, suggesting some form close to *Russula Schiffneri* Sing.   The other part of the type specimens is *Russula flava* Rom. In another (authentic) collection from Lake Pleasant, N. Y., are only specimens very much like *R. flava* (called *R. constans* Karst. in most other cases), but with no sign of any part of the fruit bodies staining gray.   In the writer's opinion, it is rather safe to consider *R. flaviceps* Peck a mere synonym of *R. flava* Rom.   Peck apparently called the forms that were not yet gray, *R. flaviceps*, and the gray ones *R. constans*.

RUSSULA NIGRODISCA Peck, apud J. M. Macoun in D. S. Jordan,
      Fur Seals N. Pacif. 3: 583.   1889.   Type.

Spores 9–10.5 × 7.4–8.2 μ, ornamentation type IIIa, sometimes II–IIIa, the network consisting of coarse and fine lines, very dense, the lines crossing each other, the warts dense, 0.3 μ high.   *Basidia* 41 × 13 μ; sterigmata four, 6–7 μ long.   *Cystidia* about 62 μ long and 7.5–14 μ thick, rather variable in length, numerous.   *Dermatocystidia* very abundant.

Conclusion: This plant is an arctic form of *Russula emetica,* and does not seem to be different from *Russula emetica* ssp. *alpestris* (Boud.) Sing. which is rather common in the Arctic as well as in the alpine region of many high mountain ranges (Alps, Caucasus).

RUSSULA BLACKFORDAE Peck, Bull. N. Y. State Mus. **139**: 43.
      1910.   Type, and fresh material from Newcomb Co., New
      York, compared with the type.

In the first part of these studies, Mycologia **34**: 89–90, 1942, the type specimens preserved at the Farlow Herbarium were examined.   Later, the part of the type specimens deposited at the N. Y. State Museum were examined and compared with fresh material collected in Newcomb Co., N. Y.   I am now in a position to identify *R. Blackfordae* with sufficient certainty.   There is no doubt that the species called *Russula serotina* Quél. sensu Melz. & Zvára or *Russula versicolor* J. Schäffer are exactly identical with *R. Blackfordae*.   Since the emendation of *R. serotina* by Melzer

and Zvára was made subsequent to the publication of *R. Black-fordae,* the latter has clear priority over *R. versicolor* J. Schäffer, the American name must be used.

Russula palustris Peck, Ann. Rep. N. Y. State Mus. **53**: 842. 1900. Type, and also fresh material, collected in Newcomb Co., N. Y., compared with the type.

Macroscopical comparison, anatomical and chemical characters show that this species is identical in every regard with what is called *Russula exalbicans* (Secr.) Melz. & Zv. by European writers. But recently other names have been preferred to Secretan's name, because Melzer and Zvára's fungus only possibly, not necessarily, belongs to *Agaricus exalbicans* of Secretan. When proposing the name *R. depallens* Fries for the same species, J. Schäffer only gave one uncertain name for another. Borszczow's pictures of *Russula pulchella* Borszc., however, are very suggestive of *R. palustris* Peck, and since no types were found in the Herbaria of the U. S. S. R., I tried, in September 1940, to find the species in the type locality, near Gaczina, Province of Leningrad, and was lucky enough to collect what hitherto I had called *R. exalbicans,* and what here has been called *R. palustris.* Borszczow claims in his description that his species is mild. Many specimens of this *Russula* are found either almost mild or even completely mild when old, when collected under certain weather conditions. It seems to me therefore that the most appropriate name for it is *Russula pulchella* Borszcz. with *R. exalbicans* sensu Melzer & Zvára and *R. palustris* Peck as synonyms (compare Borszczow, E. Fungi Ingrici Novi vel Minus Cogniti Iconibus Illustrati. Petropoli. 1857).

Some other species of *Russula* which have been studied before by the writer, although the studies were not based on the type specimens or on portions of the type only, have been restudied together with the specimens mentioned above. The results follow:

R. variata Bann. ap. Peck, identical with the form described in Fedde's Repertorium **33**: 351. 1934. [*R. cyanoxantha* var. *variata* (Peck) Sing.]

R. AERUGINASCENS Peck, a colored form of the preceding.

R. OCHROPHYLLA Peck = *R. olivacea* (Schaeff.) Fries (compare Bull. Soc. Myc. France **55**: 252. 1939.

R. DECOLORANS Fries sensu Peck, non Fries. A mixture of different *Decolorantinae,* mostly *R. decolorans* Fries var. *rubriceps* Kauffman which, however, is a good autonomous species, **R. rubriceps** (Kauffm.) Sing. comb. nov.

TRICHOLOMATACEAE

LACCARIA STRIATULA Peck, Bull. N. Y. State Mus. **157**: 93. ·1912; *Clitocybe* (Laccata) *striatula* Peck, Ann. Rep. N. Y. State Mus. **48**: 274. 1897. Type.

Spores globose or subglobose, spinose, $10.5–12.8 \times 9.5–11.5 \mu$. Spines up to 1.6μ high. *Basidia* $40–52 \times 9–10 \mu$, 2-spored.

Conclusion: This species is not identical with the specimens collected and studied for North American Flora by Murrill, nor are they identical with an externally very similar species that I collected in the Altai Mts., and determined as *"Laccaria striatula* Peck." However, both Murrill's and my plant are rather close to Peck's original *L. striatula.* Murrill's plant has been collected by the writer in 1941 in Van Cortlandt Park, N. Y. It differs in being 4-spored, and the average size of the fruit bodies probably is a little less than in Peck's type. The Altaian form differs in having spores of the same size but with much shorter spines. Since Murrill's and my *"L. striatula"* are distinct from what Peck called *L. striatula;* they have to be renamed or described as new. But the genus *Laccaria* has not yet been studied sufficiently, and it seems difficult, at least at present, to determine valid specific characters in this genus.

CLITOCYBE CARNOSIOR Peck, Ann. Rep. N. Y. State Mus. **23**: 76. 1872. Type.

The comparison of the type specimens and fresh material collected by the writer in the Adirondack Mts., shows that *C. carnosior* actually is the same as *Clitocybe clavipes* (Pers.) Fries.

CLITOCYBE ADIRONDACKENSIS Peck, Ann. Rep. N. Y. State Mus. 23: 77. 1872. (*Agaricus.*) Type.

The comparison of the type specimens and other collections with fresh material collected by the writer in the Adirondack Mountains shows that this is a good species of *Clitocybe*.

CLITOCYBE MACULOSA Peck, Bull. Buffalo Soc. Nat. Sci. 1: 45. 1873.

The comparison of the type specimens and fresh material, collected in the Adirondack Mountains, with European material of *Clitocybe gilva* (Pers.) Fries, shows that both these species are identical.

The spores are small, subglobose and distinctly warty-rough. This species belongs to the *Inversa*-group.

AGARICUS (*Tricholoma*) DECOROSUS Peck, Bull. Buffalo Soc. Nat. Sci. 1: 42. 1873. Authentic material, collected by Farlow at Shelburne, N. H.

Spores 5–5.5 (6.3) × 3.3–3.5 μ, non-amyloid, smooth. *Basidia* 21–24 × 5.3–5.8 μ, 4-spored. *Cheilocystidia* present, large. Clamp connections present. *Hyphae* of the epicutis very large, about 24 μ broad. General appearance suggesting *Pholiota squarrosoides*.

Conclusion: This species belongs to the genus *Tricholomopsis*. The new combination **Tricholomopsis decorosa** (Peck) Sing. is proposed.

AGARICUS SULFUREOIDES Peck, Ann. Rep. N. Y. State Mus. 23: 86. 1872. Type and also material collected by Kauffman in Michigan, and fresh material from the Adirondack, Mts., N. Y.

All the collections cited seem to be identical and have the following characters in common:

Spores 6.5–7.5 × 5–6.7 μ, with one oil drop, subglobose, hyaline, non-amyloid. *Basidia* 28–40 × 5.8–7.5 μ, 4-spored. *Cheilocystidia* balloon-shaped or clavate-subacuminate, 45–55 × (6.8) 12–28 μ, brown, numerous. *Hyphae* with clamp connections.

Conclusion: This evidently belongs in *Tricholomopsis,* but it does not seem to be a good species. It is hardly more than a variety of what the writer called *Tricholomopsis ornata* (Fries) Sing. in Europe and Asia. Therefore the combination **Tricholomopsis ornata** var. **sulfureoides** (Peck) Sing. comb. nov. is proposed.

OMPHALIA OLIVARIA Peck, Bull. Buffalo Soc. Nat. Sci. **1**: 48. 1873. Type.

Spores 6.5–8.5 × 4–6 μ, hyaline, smooth, non-amyloid. *Basidia* 32.5 × 7 μ, 4-spored. *Cystidia* none. *Trama* of the lamellae regular. *Hyphae* without clamp connections, non-amyloid.

Conclusion: The microscopical characters show that this species belongs to the *Umbellifera*-group of the genus *Omphalia* sensu stricto. I have mentioned this species in a previous paper as occurring in Spain. My Spanish specimens (compare Ann. Myc. **34**: 428. 1936) are somewhat different from the colored sketch that accompanies the type, and also differ from the description in some smaller details. The lamellae particularly are much narrower in Peck's figure than they are in my specimens, but the specimens have undoubtedly considerably broader lamellae than shown on the figure. I do not think that the Spanish form is specifically different from the American type.

HYGROPHORUS MARGINATUS Peck, Ann. Rep. N. Y. State Mus. **28**: 50. 1876. Type, and also from fresh material collected in the White Mts., N. H.

This species has very much the appearance of a *Hygrocybe,* but because of the lack of clamp connections it differs from other members of the Hygrophoraceae except for the closest relatives which I term the *Marginata* group. Since, because of the absence of clamp connections, *H. marginata* does not belong to the Hygrophoraceae, it is necessary to transfer the species elsewhere. The only clampless groups with identical micro-structure are *Armellariella* and *Tricholoma* subgen. *Eu-Tricholoma.* The latter is macroscopically nearer to the *Marginata* group since it contains species of which the lamellae are brightly colored and not infre-

quently comparatively thick, as in *Tricholoma* (*Eu-Tricholoma*) *sulphureum* with thick lamellae, *T. orirubens* with red lamellae, and several other species which show these same characters. I do not give more descriptive data because of the excellent description in a recent paper by Smith and Hesler (Lloydia **5**: 39. 1942). An equally good description by Kühner (Le Botaniste **17**: 53. 1926) does not mention clamp connections but it appears from the figures accompanying the description that Kühner's does have clamp connection. This fact, together with other differences shown by the French material, lead me to assume that Kühner's species is probably a *Hygrocybe,* but the type of Peck's *H. marginatus* cannot be placed in that genus and I therefore propose the binomial **Tricholoma marginatum** (Peck) Sing. comb. nov.

Tricholoma subluteum Peck, Bull. N. Y. State Mus. **75**: 21. 1904. Type.

Spores 6.7–7 × 5.3–6.5 μ, very short ellipsoid to globose, with a rather thin wall, smooth, hyaline, mostly with 1 small oil drop, non-amyloid. *Basidia* 29.5–39.5 × 6.5–10 μ, 4-spored. *Cystidia* none. *Hyphae* of the cuticle subparallel, hyaline, with no pigment visible under oil immersion lens, without clamp connections, rather thin: 0.5–3.5 μ thick.

Conclusion: *Tricholoma subluteum* belongs in the subgenus *Eu-Tricholoma.*

Tricholoma planiceps Peck, Bull. N. Y. State Mus. **42**: 112. 1889. Type.

Spores 7–7.5 × 5–6 μ, very distinctly warty, the warts strongly amyloid, leaving a smooth spot above the hilum on the inner side of the spore (plage), ornamentation type IV–VI, V. *Basidia* 27–35 × 8–9.5 μ, 4-spored, a part of them 2-spored. *Cheilocystidia* basidiomorphus. *Cystidia* fusoid or capitate-bottle-shaped, very rare and inconspicuous, 27.5–30 × 5 μ. *Trama* of the lamellae filamentous, almost regular, the hyphae without clamp connections. Observation: In the type specimen there are a few Lactarius-spores intermixed which can easily be recognized in Melzer's reagent, where they show a different type of ornamentation: I (reticulate-cristate).

Conclusion: Murrill (N. Am. Flora **10**: 7. 1914) identified *Tricholoma planiceps* with *Melanoleuca melaleuca*. The type of *T. planiceps* does, however, not agree with *M. melaleuca* unless an extremely broad conception of this latter species is admitted. Therefore, the combination **Melanoleuca planiceps** (Peck) Sing. comb. nov. is proposed.

MELANOLEUCA ALBOFLAVIDA (Peck) Murr., N. Am. Flora **10**: 6. 1914, non Singer, Cavanillesia **7** (6–9): 123. 1935. *Agaricus* Peck, Ann. Rep. N. Y. State Mus. **23**: 75. 1872. Peck's types and other authentic materials, Murrill's collections and authenticated material at the N. Y. Botanical Garden and fresh material from Huntington Forest, Newcomb Co., N. Y., collected by R. Singer, and compared with the type material.

Pileus white with a honey yellow center, or "pinkish buff" to "warm buff" (R.) all over, convex, soon flat, but frequently bluntly umbonate, 46–73 mm. broad. *Lamellae* sordid-greyish-yellow (very pale), very crowded, emarginate, sinuate, medium broad: 5–7 mm. broad. *Spores* 8–9.5 × 4.5–5.4 μ, hyaline under the microscope, but creamy white (about B, Crawshay) in mass, ellipsoid, with small, but distinct isolated warts, decidedly amyloid. *Basidia* 26.5–37 × 7–8.5 μ, 4-spored. *Cystidia* fusoid or more often subulate, acute, more rarely obtuse, the thickest part 9–15 μ thick (mostly 10–11 μ in diameter), 45–65 μ long, hyaline, with rather thin walls, abundant on the edge of the lamellae, less abundant near the edge, and mostly lacking on the sides, the apex with or without the needle shaped barb-like crystals. Stipe pale at apex, white to pale greyish brown in the middle, white to greyish brown on the base, fibrillose and somewhat turned, 50–93 × 4–11 mm. (at apex) 6–18 mm. (at base), slightly thickened to decidedly bulbous at base. *Context* whitish to subconcolorous at some places. Taste mild. Odor none, or slightly recalling the odor of *Inocybe geophylla* or flowers of *Berberis vulgaris*. Becoming moderately quickly and intensely violet with methylparamidophenol (reaction decidedly positive). Hyphae thin, without clamp connections. Habitat: Mostly in deciduous woods.

Conclusion: When adopting the name *Melanoleuca alboflavida* for the European species, called *Tricholoma cnista* by Bresadola, I relied on the statement of Bresadola who gave the first indication

of the identity of the American species with the European one. But studies on American material show that the species called *Melanoleuca alboflavida* by American authors is quite different from the European plant. This latter is a species growing in the subalpine meadows of the Alps, the Pyrenees, the Caucasus and has pure white spore powder when the print is made on white paper. The spores of *Melanoleuca alboflavida* have a creamy spore powder, and grow in woods or more or less open places but near deciduous trees in lower altitudes (up to 3000 feet). In previous type studies (Lloydia **5**: 122. 1942), I have shown that *Collybia sedula* Graff is a *Melanoleuca*. When comparing Graff's types with Peck's types, and the description of *Collybia sedula* with my notes on fresh material of *Melanoleuca alboflavida*, I came to the conclusion that both these species are identical. Consequently *Collybia sedula* is a synonym of *Melanoleuca alboflavida*, while *Melanoleuca alboflavida* sensu Singer, non Peck, becomes a synonym of *Melanoleuca evenosa* (Sacc.) Konrad (= *Tricholoma cnista* sensu Bres. non Fries.).

MARASMIUS UMBONATUS Peck, Bull. Buffalo Soc. Nat. Sci. **1**: 58. 1873. Authentic material, coll. Macoun, det. Peck, ex Herb. Ellis, FH.

Hyphae of the cuticle almost smooth, repent, filamentous.

Conclusion: This is a species of *Collybia*, not a *Marasmius*, and since there is another *Collybia umbonata* Peck (Bull. Torrey Club **31**: 178. 1904) the name of *Marasmius umbonatus* has to be changed. The new name **Collybia umbonatella** Sing. nom. nov. is proposed.

COLLYBIA LACUNOSA Peck, Ann. Rep. N. Y. State Mus. **44**: 176. 1891. Type, and fresh material, collected by R. Singer in the Adirondack Mts., compared with the type.

LENTINUS CHRYSOPEPLUS Berk. & Curt., Jour. Linn. Soc. **10**: 301. 1868. Type in Curtis' Herbarium (FH), and recently collected materials from Brazil, coll. and det. Rick as an unpublished new species, older material from São Paulo and Porto Novo, Brazil, det. Patouillard (*M. aculeatus*).

Agaricus scabriusculus Peck, Ann. Rep. N. Y. State Mus. **23**:
85. 1872. Type.

Marasmius aculeatus Pat., Bull. Soc. Myc. France **16**: 175.
1901. Type, and authentic material from Guadeloupe, coll.
Duss, det. Patouillard, 1903.

The types of all these species have been studied. They have the
following microscopical characters in common, and no differentiat-
ing macroscopical features of specific value have been discovered:

Spores 7.5–10.5 × 5–7.8 μ, hyaline, smooth, ellipsoid-lemon-
shaped, sometimes all thin-walled, sometimes some of them more
or less thick-walled, sometimes subangular, with no or indistinct
depression, non-amyloid. *Basidia* very narrow, 40–50 (61) × 6–
7 μ. *Cystidia* 50–55 (75) × 9.5–10 (13) μ, clavate, more rarely
ventricose, thick-walled or thin-walled. *Hyphae* non-amyloid,
with clamp connections. *Floccose covering* of the pileus consist-
ing of a palisade of erect hairs; hairs clavate, 18–100 × 7-15 μ,
from yellowish hyaline to very bright yellow, thick-walled, the
walls 1.7–3.5 μ thick, consisting of two layers, the outer layer non-
amyloid, the inner thicker layer sometimes being pseudoamyloid,
the connecting septum between the clavula and the last hypha
bearing a clamp, the clavula itself sometimes branched near the
septum. *Hairs of the stipe* 50–100 × 8–10 μ, some slightly pseu-
doamyloid, but the majority not pseudoamyloid, similar in shape
and color to the hairs of the pileus.

Conclusion: This species does not belong to any of the many
genera to which it has been referred by authors. The thick-walled
hairs of the covering layers suggest a *Crinipellis* but the reaction
with iodine is much too slight where it is observed at all, and the
hairs are arranged in palisade-like clusters. Its characters agree
fairly well with the generic characters of the genus *Xerula*, and
the writer thinks that it has to be ranged in this genus. The oldest
specific name being that of Berkeley and Curtis, the new combina-
tion **Xerula chrysopepla** (Berk. & Curt.) Sing. comb. nov. is pro-
posed. The writer has not seen any specimens referred to *Agaricus*
(*Pleurotus*) *aureotomentosus* Kalchbr. ap. Kalchbr. & Cooke (Gre-
villea **9**: 17. 1880) except for one collection in the Patouillard
Herbarium (FH) from New Caledonia, coll. Le Rat, det. "*Ma-
rasmius aureotomentosus* (*Pleurotus, Kalchbr.*) = *M. aculeatus*

Pat." by Patouillard. Since Patouillard himself identifies his species with Kalchbrenner's African species, and the original description of the Port Natal plant agrees well enough with the material collected in the Western Hemisphere, I am inclined to think that it belongs to the same species. A more orange color—in contrast with *X. chrysopepla* which is about "light cadmium"—is shown in De Seynes' picture (*pl. 3, fig. 8–10*) of his *Clitocybe verruculosa* (compare also the description of De Seynes in Champignons du Congo français 1: 7. 1897), but since the other characters seem to agree with the characters of *Agaricus aureotomentosus*, it probably is nothing but a color variation of *Xerula chrysopepla*.

Consequently, the synonymy of *Xerula chrysopepla* (Berk. & Curt.) Sing. would consist of the following binomials:

Lentinus chrysopeplus Berk. & Curt. (1868).

Agaricus scabriusculus Peck (1872).

Agaricus (Tricholoma) lacunosus Peck (1873).

Agaricus (Pleurotus) aureotomentosus Kalchbr.; Kalchbr. & Cooke (1880).

Omphalia scabriuscula Sacc. (1887).

Tricholoma lacunosum Sacc. (1887).

Pleurotus aureotomentosus Sacc. (1887).

Collybia lacunosa Peck (1891).

Clitocybe verruculosa De Seynes (1897)—a variety?

Marasmius aculeatus Pat. (1901).

Gymnopus chrysopeplus Murr. (1916).

This list of synonyms shows that Murrill (N. Am. Flora 5: 359 and 376. 1916) gave an almost complete picture of the synonymy of this fungus. His statements are confirmed by the writer's type studies.

AGARICUS TENUIPES Schwein. Syn. Am. Bor. 147. 1832.

> *Agaricus rhabarbarinus* Berk. Jour. Bot. & Kew Misc. 8: 135. 1856. Authentic material in Curtis Herbarium (FH).
>
> *Marasmius amabilipes* Peck, Bot. Gaz. 4: 216. 1879. Type and authentic material.

The cited specimens are identical in every regard with the species described in Lloydia 5: 127. 1942. They are, consequently,

synonyms of what is called *Gymnopus tenuipes* (Schwein.) Murrill in North American Flora. The writer has not seen authentic specimens of this latter species, but C. G. Lloyd seems to be very positive on the identity of *Agaricus tenuipes* and *Marasmius amabilipes,* and since this opinion is not seriously opposed by any strong argument but on the contrary, seems to be accepted by a majority of authors, the writer believes that Schweinitz's name can be used for the species in question, and therefore the new combination **Heimiomyces tenuipes** (Schwein.) Sing. comb. nov. is proposed.

Agaricus (Collybia) spinuliferus Peck, Ann. Rep. N. Y. State Mus. 24: 62. 1872. Authentic material from the Burt Herbarium (FH).

This is identical, in every regard, with European material of *Marasmius cohaerens* (Pers.) Quél. (= *Marasmius ceratopus* (Pers.) Quél.).

Agaricus succosus Peck, Bull. Buffalo Soc. Nat. Sci. 1: 46. 1873. Type specimen and authentic material.
Mycena atramentosa v. Höhnel, Frag. Myc. 3 (no. 97), 1907. Material of the von Höhnel Herbarium (FH).

The above mentioned materials are identical, as suggested by Kühner. The following anatomical description will complete the description given by Kauffman & Kühner (Kühner, Le genre Mycena, p. 532, 1939), Bresadola (Icon. Myc. *pl. 216, fig. 1.* 1928), and v. Höhnel (l.c.).

Spores 4.2–6 × 3.2–4.5 μ, very shortly ellipsoid, with slight or no depression, hyaline or frequently becoming brown on the lamellae, with thin, amyloid walls, smooth. *Basidia* about 6.5 μ broad. *Cheilocystidia* mostly rather variable in size, from 3.5–16 μ broad, hyaline or brownish, incrusted or not, very numerous, filamentose-cylindrical, filamentose-claviform, filamentose-ampullaceous, or vesiculose-balloon shaped. *Cystidia* none. *Laticiferae,* which are everywhere numerous, on the surfaces and edges of the black lamellae, frequently discolor large portions of tissue, basidia and even spores that become brownish to dark fuligineous. *Epicutis* similar to the surface layer of **Hydropus marginella** (Pers.)

Sing. comb. nov. [*Omphalia marginella* aut.] and its variety var. *rugosodiscus* (Peck) Joss. & A. H. Smith, but the bodies of the epicutis seem to be unequally distributed and rather transitory, and may sometimes be replaced by small irregular, strongly incrusted elements. In the subcutis very numerous black or blackish-brown granulose laticiferae, and hyphae with a distinct membrana-pigment. *Hyphae* of the trama non-amyloid.

Conclusion: The above data prove that *Mycena fuliginaria* (*Collybia succosa, Mycena atramentosa*) belongs to the genus *Hydropus*. The combination **Hydropus fuliginarius** (Batsch.) Sing. comb. nov. is proposed.

PANUS DEALBATUS Berk., London Jour. Bot. **6**: 317. 1847. Material from Curtis Herbarium (FH) that must at least be authentic (Ohio), and more recently collected material from Ohio (Morgan), determined by Peck.

Spores 6–9.5 × 2.3–4 μ, mostly 6.5–7.5 × 2.7–3.3 μ, cylindrical, subfusoid, or somewhat curved, smooth, hyaline, non-amyloid, very thin-walled, with one central oil drop. *Basidia* 19–21 × 4–5.5 μ, thin-walled except for the upper half with a medium thick (about 0.5 μ) wall, sometimes the wall is up to 2.5 μ thick, and then the basidia are sterile. *Gill trama* consisting of strongly and irregularly interwoven filamentose, about 2 μ thick, thin-walled hyphae with a tendency, in some specimens, to protrude into the hymenial layer among the basidia; clamp connections present. *Surface layer of the pileus* consisting of hyaline 2.5–3.5 μ thick hyphae with spine-like short branches of 3.5–6 μ length and about 1 μ diameter on their base, their axis mostly forming an angle of about 90° with the main hypha, the terminal branches of each hypha often shorter and stellate, about 1.5 μ long, all branches with more or less blunt tips, the hyphae walls about 0.6 μ thick.

Conclusion: This extraordinary fungus is not related to any other species of the genus *Panus* nor to another known genus. The structure of the surface layer of the pileus is unique in the Agaricales, and can be compared only with the structure of the genus *Vararia* (*Asterostromella*) in the Aphyllophorales. It is true that the organization of the hymenophore shows a great variety in the genus *Vararia*. Thus Bondarzew and Singer (Ann. Myc. **39**: 48. 1941) referred the "Poria" *P. luteopora* Bond. to *Asterostromella*, but since D. P. Rogers has shown that *Vararia*

Karst. has priority for this group, the combination **Vararia luteo-pora** (Bond.) Sing. comb. nov. should be used. Nevertheless, it does not seem that actual natural relations exist between *Panus dealbatus* and *Vararia*. *Marasmius cohaerens* and an undescribed new species of Boletaceae from Liberia that I have studied recently, have typical setae, but they are neither related one to another, nor are they related to setae bearing Polypores (*Inonotus, Phellinus, Cyclomyces*) or Corticiineae (*Hymenochaete, Hydnochaete, Asterodon*, etc.). Thus, it has to be admitted that the so-called *"Asterostromella*-structure" occurs among the Agaricales, *Panus dealbatus* being the first and only species in which it has been discovered. Since *Panus dealbatus* differs from other genera of Pleurotoideae where it could be ranged, if the anatomy of the pileus is neglected, I propose the following genus for this striking species:

Asterotus Sing. gen. nov.

Pileo flabelliformi. Stipite laterali, compresso. Contextu molliter subcoriaceo. *Strato superficiali pilei ex hyphis structuram generis Varariae revocantibus composito.* Sporis oblongiusculis levibus, hyalinis, inamyloideis. Basidiis saepe crassotunicatis ad apicem. Cystidiis nullis. Trama lamellarum e hyphis tenuitunicatis vel mediocriter tunicatis, valde intertextis, tenuibus efformata. Hyphis non gelatinosis, fibuligeris, hyalinis. Ad ligna. —Species typica: *Panus dealbatus* Berk.

For *Panus dealbatus,* the new combination **Asterotus dealbatus** (Berk.) Sing. comb. nov. is proposed.

AMANITACEAE

Amanita Frostiana Peck, Ann. Rep. N. Y. State Mus. **33**: 44. 1883. Type.

Spores 5.5–10 $\times$ 5–7 μ, short ellipsoid, some almost subglobose, smooth, non-amyloid. *Gill trama* bilateral.

Conclusion: While Peck and Atkinson as well as Kauffman considered *Amanita Frostiana* Peck and *Amanita flavoconia* Atkinson as distinct species, it has been suggested by Murrill (1914), Coker (1917) and others that both these species be mere synonyms. The iodine reaction shows that they are not only good species, but

belong to different subgenera: *A. Frostiana* Peck belongs to sub
genus *Pseudoamanita* Sing. (1936), together with *A. muscaria*
(L.) Pers., and *A. flavoconia* Atk. belongs to subgenus *Euamanita*
Sing. (1936) because of its amyloid spores.

CORTINARIACEAE

PHOLIOTA DUROIDES Peck, Bull. N. Y. State Mus. **122**: 148.   1908.
    Type.

Spores 4–6.3 × 3–4.5 μ, subellipsoid to ovoid, pale honey color,
smooth, without germ pores.   *Cystidia* few or lacking on the
sides of the lamellae, but numerous on the edge, clavate, with a
yellow refringent amorphous body in the broadest part.   *Epicutis*
of the pileus consisting of repent radial, filamentose, smooth,
scarcely or somewhat mucilaginous, rather parallel, 4.5–6.5 μ thick
hyphae, with clamp connections.

Conclusion: This species has typical *Flammula*-cystidia, and
therefore cannot be ranged in *Pholiota* merely because of the
presence of an annulus, an evidently secondary character.   The
writer has pointed out that *Flammula Freindlingiae* Sing. although
distinctly annulate, is a species of *Flammula* (compare Beih. Bot.
Centralbl. Abt. B, **46**: 170.   1936).   **Flammula duroides** (Peck)
Sing. comb. nov. differs from *F. Freindlingiae* in brighter colors
and lacking or with but slight viscosity of the cuticle.

TUBARIA LUTEOALBA Longyear, Bot. Gaz. **28**: 272.   1899.   Type
    specimens from Albany.

Under this name, the writer has published a collection from the
Caucasus Mts. (Beih. Bot. Centralb. Abt. II, **48**: 531.   1931)
which however belongs to *Cortinarius* (see Rev. de Myc. **4**: 72.
1939).   The American types of this species are very much like
my Caucasian material in general appearance, and their original
description fits them rather well, but the spores are not rough, they
have rather thin walls and so little pigmentation that they appear
almost hyaline.   Their measurements, as found in the Albany
types, are 7–9.5 × 4.5–4.8 μ.   This species, consequently, cannot
be a *Cortinarius*, but most probably is an actual *Tubaria*.

AGARICUS TILIOPHILUS Peck, Ann. Rep. N. Y. State Mus. **35**: 133. 1884. Type, and fresh material, compared with the type, collected by W. L. White & R. Singer in Purgatory Swamp, Norwood, Mass.

The following description covers abundant fresh material as well as the type collection:

Pileus watery brown and somewhat hygrophanous, buffy brownish when dry, not viscid, somewhat pruinate or faintly rivulose at last, the margin subincurved when young, transparently striatulate when moist, largest diameter of the convex pileus 8–25 mm.; dermatocystidia numerous, forming the faint pruinosity of the pileus, the epicutis not hymeniform, the dermatocystidia forming the terminal members of ascendent or erect hyphae of the subcutis, very similar to the cheilocystidia of the hymenium, hyaline or brown, rather thin-walled although with thicker walls than the basidia, often curved, broad cylindrical, clavate, or sometimes bottle-shaped, 16–36 × 4.5–8 μ; hyphae of the subcutis mostly colored, with a membrana pigment, horizontal, subparallel. *Lamellae* argillaceous brown, very broad, moderately close, adnate or adnexed; spore print on white paper dirty brownish; spores 6.5–8 × 4.2–5.5 μ, ovoid, rather pale under the microscope, smooth, with rather thin, not distinctly double wall, germ-pore not seen; basidia 16.3 × 6.5 μ; cheilocystidia almost exactly like the dermatocystidia but mostly clavate, 25–40 × 4.5–10 μ; cystidia lacking. *Stipe* pale brownish, sometimes whitish or light buff, somewhat longitudinally fibrillose, often distinctly white pubescent at base, equal or subequal, straight or more often curved, eventually hollow, eccentric or central, 5–20 × 1–5 mm. *Context* almost concolorous, thin, inodorous, consisting of strongly interwoven, almost intermixed hyphae. *Habitat:* Gregarious, on dead wood and branches of *Tilia americana* and other frondose trees.

Conclusion: The characters of this species refer it to *Naucoria* Fries sensu stricto Sing. rather than to *Crepidotus*. Thus, the new combination **Naucoria tiliophila** (Peck) Sing. comb. nov. is proposed.

NOTES ON THE USTILAGINALES OF THE WORLD III[1]

GEORGE L. ZUNDEL

(WITH 4 FIGURES)

The following new species have been found from specimens recently received while working on the Ustilaginales of the world. Some corrections are also included in this paper:

USTILAGINALES OF SOUTH AFRICA

Additional specimens from the Union Department of Agriculture, Mycological collection, Pretoria, have given the following new species and new hosts for old species.

1. Ustilago Ehrhartana Zundel, sp. nov.

Sori destroying the inflorescence, at first covered by a delicate membrane of host tissue which disintegrates exposing a dark-brown, powdery spore-mass; spores globose to broadly ellipsoidal, olivaceous-brown, with an epispore 1.5–2 μ thick, chiefly 10.5–14 μ in diameter, smooth.

Soris inflorescentiam destruentibus, primo tenui membrana ipsius inflorescentiae tectis, membrana dissoluta massam sporarum fusco-brunneam atque pulverulentam ostendit; sporis globosis vel late ellipsoideis, olivaceo-brunneis, episporo 1.5–2 μ crasso, plerumque 10.5–14 μ diam., levibus.

Hab. in *Ehrharta erecta* Louv. var. natalensi Stapf.

On *Ehrharta erecta* Louv. var. *natalensis* Stapf, on mountain top, in the shade of a large *Fiscus,* Ingwavuma district, Natal. Coll. O. West (*915*), Nov. 29, 1938 (U. D. *30501*).

2. Ustilago Eragrostidis-japonicana Zundel, sp. nov.

Sori in the ovaries, minute, ovate, about 1 mm. or less in diameter; spores chiefly globose to subglobose, somewhat irregular, olivaceous-brown, chiefly 7–8 μ in diameter, minutely verruculose.

Soris in ovariis, minutis, ovatis, 1 mm. plus minusve diam.; sporis plerumque globosis vel subglobosis, aliquantum irregularibus, olivaceo-brunneis, plerumque 7–8 μ diam., minute verruculosis.

Hab. in *Eragrostide japonica* Trin.

On *Eragrostis japonica* Trin., Welgelegen, Vryburg district, Cape Province. Coll. G. A. Pentz, April 1925 (U. D. *20621*).

3. Ustilago Liebenbergii Zundel, sp. nov.

Sori destroying the inflorescence, hidden by the upper leaf sheaths, covered by a membrane which ruptures exposing a black powdery spore-mass; spores globose to broadly ellipsoidal, somewhat irregular, semi-opaque, chiefly 10.5–14 μ diameter, smooth.

Soris inflorescentiam destruentibus, vaginis superioribus folii celantibus, membrana rupta massam atram pulverulentamque sporarum detegit; sporis globosis vel late ellipsoideis, aliquantum irregularibus, semi-translucidis, plerumque 10.5–14 μ diam., levibus.

Hab. in *Chloride virgata* Sw.

On *Chloris virgata* Sw., Vlakfontein, Wolmaransstad district, Transvaal. Coll. L. C. C. Liebenberg, July 1932 (U. D. *26412*).

4. Ustilago Mariscana Zundel, sp. nov.

Sori destroying the ovaries, ovate, protected by the enveloping flower parts, powdery, spore-mass dark-brown; spores globose to subglobose, ellipsoidal or elongated, somewhat irregular, olivaceous-brown, chiefly 10.5–13 μ diameter, smooth.

Soris ovaria destruentibus, ovatis, a partibus floris amictis, pulverulentis, massa sporarum fusco-brunnea; sporis globosis vel subglobosis, ellipsoideis vel elongatis, aliquantum irregularibus, olivaceo-brunneis, plerumque 10.5–13 μ diam., levibus.

Hab. in *Marisco sieberiano* Nees., etc.

On *Mariscus sieberianus* Nees., Infulzane, Melmoth district, Natal. Coll. by A. O. D. Mogg (*6096*), Dec. 1, 1919 (U. D. *33062*).

5. **Ustilago Tragana** Zundel, sp. nov.

Sori in the ovaries, swollen, ovate, 2.5–3 mm. in diameter, covered by a tough greenish membrane which ruptures exposing a dark-brown, powdery spore-mass; spores chiefly subglobose to broadly ellipsoidal, occasionally globose, olivaceous-brown, chiefly 8.5–10.5 μ in diameter, abundantly echinulate.

Soris in ovariis, tumentibus, ovatis, 2.5–3 mm. diam., membrana dura et subviridis rupta massam fusco-brunneam pulverulentamque sporarum ostendit; sporis plerumque subglobosis vel late ellipsoideis, interdum globosis, olivaceo-brunneis, praecipue 8.5–10.5 μ diam., abundanter echinulatis.

Hab. in *Trago racemoso* All., etc.

On *Tragus racemosus* All., Potgietersust district, Transvaal. Coll. Dr. I. B. Pole-Evans about March 1936 (U. D. *28708*) (Type) ; Hollandsdrift, Pietersburg district, Transvaal. Coll. A. M. Bottomley, April 26, 1937 (U. D. *28784*).

6. **Ustilago Trichoneurana** Zundel, sp. nov.

Sori in the upper leaves and culms as short striae, about 1 to 2 cm. long, covered by a membrane which ruptures freeing a dark-brown, powdery, spore-mass; spores globose to subglobose often irregular, bright olivaceous-brown, chiefly 6.5–8 μ in diameter, smooth.

Soris striaformibus in foliis superioribus et culmis, ca. 1–2 cm. longis, membrana rupta massam fusco-brunneam atque pulverulentam sporarum detegit; sporis globosis vel subglobosis, saepe irregularibus, dilute olivaceo-brunneis, plerumque 6 5–8 μ diam., levibus.

Hab. in *Trichoneura grandiglumi* Stapf et Hubb.

On *Trichoneura grandiglumis* Stapf & Hubb., Edendale, Pretoria district, Transvaal. Coll. by A. O. D. Mogg, Nov. 28, 1929 (U. D. *22844*).

7. **Ustilago Urochloana** Zundel, sp. nov.

Sori destroying the ovaries, ovate, about 2 mm. long, protected by the glumes, covered by a delicate membrane which ruptures freeing a dark-brown granular spore-mass; spores irregularly globose to subglobose, sometimes angled, light reddish-brown, chiefly 8.5–10.5 μ in diameter, apparently smooth but very minutely verruculate under high magnification.

Soris ovaria destruentibus, ovatis, ca. 2 mm. longis, a glumis tectis, membrana delicata rupta massam sporarum fusco-brunneam et granularem de-

tegit; sporis irregulariter globosis vel subglobosis, interdum angulatis, dilute rubro-brunneis, plerumque 8.5–10.5 µ diam., apparenter levibus vero minute verruculatis sub immersione ut dicunt olei visis.

Hab. in *Urochloa trichopo* Stapf.

On *Urochloa trichopus* Stapf, Brown's Kuil Drift, Crocodile River, Transvaal.   Coll. by A. O. D. Mogg, June 8, 1921 (U. D. *20690*).

8. SOROSPORIUM CONSANGUINEUM Ellis & Ev.

On *Lodetia simplex* (Nees) Hubb., Meintjies Kop, Pretoria, Union of South Africa.   Coll. A. O. D. Mogg, March 18, 1930 (Union Dep. Agr. Myc. No. *25314*).

9. ENTYLOMA FUSCUM Schröt.

On *Papaver Rhoeas* L., Berea, Durban, Natal, Union of South Africa.   Coll. A. P. D. McClean, Dec. 22, 1938 (Union Dep. Agric. Myc. No. *30453*).

CHINESE USTILAGINALES COLLECTED IN COÖPERATION BETWEEN
THE FARLOW HERBARIUM OF HARVARD UNIVERSITY
AND THE UNIVERSITY OF NANKING

1. **Ustilago anhweiana** Zundel, sp. nov.

Sori destroying the inflorescence, globose about 3 mm. diameter, forming a yellowish-brown, dusty, spore mass; spores globose to subglobose, regular, olivaceous-brown, chiefly 7–11 µ diameter, with rather fine winged reticulations.

Soris inflorescentiam perdentibus, globosis, ca. 3 mm. diam., massa sporarum pulverulenta, fusco-brunnea; sporis globosis vel subglobosis, regularibus, olivaceo-brunneis, plerumque 7–11 µ diam., minute reticulatis.

Hab. in *Polygono* sp. Ping Tou Ssu, etc.

On *Polygonum* sp., Ping Tou Ssu, Ch'ing Yan Hsien, Chin Hua Shan, Anhwei Prov., China.   Fungi of Anhwei Province, China No. *1496*.   Coll. S. Y. Cheo, XI/7/1932.

2. USTILAGO EGENULA Syd. & Butler

On *Eragrostis tenella* (L.) Beauv., T'ien T'ai Wân Ch'ing Yang Hsien, Chiu Hua Shan, Anhwei Prov., China.   Coll. S. Y. Cheo, Oct. 14, 1932, No. *1247*.

3. Sphacelotheca Cheoana Zundel, sp. nov.

Sori destroying scattered ovaries in the panicle, ovate, flattened, covered by a delicate brown membrane, spore mass semi-powdery surrounding a short columella; sterile cells abundant, hyaline, in twos or short chains, often having a yeast-like appearance, globose to elongate often irregular chiefly $5-8\,\mu$ diameter, smooth; spores globose to ellipsoidal, regular, olivaceous-brown, chiefly $7-10\,\mu$ long, minutely and abundantly echinulate.

Soris ovaria dispersa perdentibus, ovatis, planis, membrana delicata et brunea; massa sporarum semi-pulverulenta brevique collumellae circumstante; cellulis sterilibus, abundantibus, hyalinis, duplicibus vel catenatis, speciem fermenti saepe praebentibus, globosis vel elongatis, saepe irregularibus, plerumque $5-8\,\mu$ diam., levibus; sporis globosis vel ellipsoideis, regularibus, olivaceo-brunneis, plerumque $7-10\,\mu$ longis, minute et abundanter echinulatis.

Hab. in *Eragrostide cilianensi* (All.) Link.

On *Eragrostis cilianensis* (All.) Link, Sha Kan, Ch'ing Yang Hsien, Chu Hua Shan, Prov. Anhwei, China. Fungi of Anhwei Province, China No. *1392.* Coll. S. Y. Cheo, X.24.1932.

4. SPHACELOTHECA SCHWEINFURTHIANA (Thüm.) Sacc. var. minor Zundel, var. nov.

Differs from the species by the smaller spores which are $7-9\,\mu$ diameter, otherwise agreeing with the species.

A specie differt maxime sporis minoribus, $7-9\,\mu$ diam. -
Hab. in *Saccaro arundinaceo* Ritz, etc.

On *Saccharum arundinaceum* Retz., Ta Tseh Tsuen, Yung Hsien, Kwangsi Province, China. Coll. S. Y. Cheo, 5–VIII, 1933 (Fungi of Kwangsi Province, China, No. *2362*).

NOTES CONCERNING USTILAGO CARBO COLUMELLIFERA TULASNE, ANN. SCI. NAT. III 7: 81. 1847

In 1847 Tulasne in his memoir on the Ustilaginales coined the name *Ustilago Carbo columellifera* giving a very imperfect description and giving a long list of hosts. In 1910, McAlpine when working on his Smuts of Australia found a specimen in the National Herbarium collected at Rochampton, Queensland, labeled *Ustilago Carbo* var. *columellifera* on *Andropogon australis* Spreng.

After studying this specimen McAlpine concluded that it was a *Cintractia* and changed the name to *Cintractia columellifera* (Tul.) McAlp.[2]

In 1928 Ciferri apparently worked with a similar fungus and published the name *Sphaceiotheca columellifera* (Tul.) Ciferri [3]

FIG. 1. *A, Sphacelotheca McAlpineae* Zundel, on *Trachypogon mollis.* Brazil. Poto by Kribs. *B, Cintractia Standleyana* Zundel. Type. Photo by Kribs.

without giving a description or source of material. In 1930, Zundel [4] accepted this name using a specimen labeled *Cintractia columellifera* from New South Wales on *Andropogon intermedius* R. Br. as a basis for this acceptance. Furthermore, Zundel [5] in

[2] McAlpine, D., Smuts of Australia 166. 1910.
[3] Ann. Myc. **26** : 32. 1928.
[4] Mycologia **22** : 139. 1930.
[5] Mycologia **25** : 353. 1933.

1933 working with a Brazilian smut on three species of *Trachypogon* found that this smut was identical to the one on *Andropogon* from New South Wales and therefore used the name *Ustilago Carbo columellifera* Tul. for the Brazilian smut.

Yen [6] in 1937 working in Paris published the name *Sphacelotheca columellifera* Yen on *Andropogon Lanigeri* Desf. from Morocco.

Since the description published by Yen did not agree with those previously published by McAlpine and Zundel, type specimens were requested from the Tulasne herbarium in Paris. Two specimens were received and were found to belong to two different genera viz., a *Sphacelotheca* and a *Sorosporium*. These specimens also differed from the Australian, the Brazilian and the Morocco specimens. Zundel [7] therefore named the Tulasne specimens *Sphacelotheca transfissa* and *Sorosporium trichophorum*. The Australian specimen was then named *Sphacelotheca McAlpineae* Zundel and the Yen specimen was named *Sphacelotheca Yenii* Zundel. The Yen specimen was later found to be identical to *Sphacelotheca Lanageri* (P. Magnus) Maire.

More material of the smut on *Trachypogon* has recently been sent in for study and the specimens previously reported as *Sphacelotheca columellifera* (Tul.) Ciferri in Mycologia **25**: 353. 1933, have been reexamined. All were found to agree with *Sphacelotheca McAlpineae*. The South American distribution of this smut is as follows:

On *Trachypogon canescens* Nees, campo, altitude 700–725 meters, Casa Branca, São Paulo, Brazil. Coll. Agnes Chase, Jan. 16, 1930. Plants of Brazil No. *10598½*.

On *Trachypogon mollis* Nees, open campo summit, altitude 1,100–1,500 meters, Pocos de Caldas, Minas Geraes, Brazil. Coll. Agnes Chase, Jan. 18–20, 1930. Plants of Brazil No. *10628,* also Buritys, near Rio São Francisco, Minas Geraes, Brazil. Coll. Agnes Chase, Jan. 1, 1930. Plants Brazil No. *10452½*.

On *Trachypogon Montufari* (H. B. K.) Nees, sandy campo, altitude 300–325 meters, Tres Lagoas, Motto Grasso, Brazil. Coll. Agnes Chase, Feb. 4–5, 1930. Plants of Brazil No. *10721½*; San Juan de los Morros, Estado. Guarico, Venezuela. Coll. A. S.

[6] Rev. Myc. n.s. **2** : 76. 1937.
[7] Zundel, G. L. Mycologia **31** : 581. 1939.

Müller, April 27, 1938 (Ministerio de Agric. y Cria, Estac. Exper. de Agric. y Zooecnia No. *2155*).

USTILAGINALES OF CENTRAL AND SOUTH AMERICA

Additional new species and other collections in Guatemala and Venezuela are reported as follows:

1. **Cintractia Standleyana** Zundel, sp. nov.

Sori destroying the ovaries and converting them into a loose powdery spore-mass, groups of infected ovaries becoming distorted and swollen at intervals along the stem; spores globose to broadly ellipsoidal, regular, dark reddish-brown, chiefly opaque, 12–15.5 μ diameter, indistinctly but abundantly pitted to almost reticulate.

Soris ovaria perdentibus et in laxam pulverulentamque massam sporarum convertentibus; ovariis infectis inde distortis et passim per caulem tumentibus; sporis globosis vel late ellipsoideis, regularibus, fusce atrobrunneis, plerumque opacis, 12–15.5 μ diam., parum clare sed abundanter maculatis vel paene reticulatis.

Hab. in *Rhynchospora glauca* Vahl, etc.

On *Rynchospora glauca* Vahl, Dept. Alta Verapaz, Guatemala: Large swamp east of Tactic, alt. about 1450 m. Coll. Paul C. Standley, April 14, 1941. Standley Field Expedition of Field Museum of Natural History, Plants of Guatemala No. *92624*.

Farysia Chardoniana Zundel, sp. nov.

Sori infecting individual spikelets throughout the inflorescence, globose, usually solitary 4–5 mm. diameter, spore-mass brown interspersed with numerous elaters; spores globose to broadly ellipsoidal, occasionally irregular, light reddish-brown, chiefly 5–8 μ diameter, abundantly verruculate and frequently spirally or longitudinally striate.

Soris singulas spiculas per totam inflorescentiam inficientibus, globosis, plerumque solis, 4–5 mm. diam., massa sporarum numerosis elateribus ut dicunt distincta; sporis globosis vel late ellipsoideis, interdum irregularibus, dilute rubro-brunneis, plerumque 5–8 μ diam., abundanter verruculatis et saepe in cochleam vel longitudinem striatis.

Hab. in *Carice polystachya*.

On *Carex* sp., Mountain above Hacienda Cura (1500 m.) state of Carabobo (type). Coll. Carlos E. Chardon and A. H. G. Alsten,

Myc. Explor. of Venezuela, Cornella University No. *2772;* on *Carex polystachya* Sw.; Dept. Jalapa. Brushy oak slopes of Cerro Alcoba, east of Jalapa, alt. 1400–1500 m. Coll. Paul C. Standley, Nov. 13, 1940, Standley Field Expedition of Field Museum of Natural History, Plants of Guatemala No. *77219;* Dept. Chimaltenango: Along road between Chimaltenango and San Martin Jilotepeque, alt. 1500–1700 m. Coll. Paul C. Standley, Dec. 22, 1940, Standley Field Expedition of Field Museum of Natural History, Plants of Guatemala No. *80871.*

3. FARYSIA OLIVACEA (D. C.) Sydow.

On *Carex polysticha* Boeckl., Dept. Baja Verapaz: Along margin of the big swamp below Pantin, alt. about 1575 m. Coll. Paul C. Standley, April 4, 1941.

4. MYCOSYRINX CISSI (D. C.) G. Beck.

On *Cissus sicyoides* L., between Rio Jute and Rio Pantaleon, on the road between Escuintla and Santa Lucia Cotz, Dept. Escuintla, alt. 540–720 m. Coll. Paul C. Standley, Jan. 24, 1939, Sewell Avery Expedition of the Field Museum of Natural History, Plants of Guatemala No. *63503;* Dept. Santa Rosa: Near Cuilapa, alt. about 895 m. Coll. Paul C. Standley, Stanley Field Expedition of Field Museum of Natural History, Plants of Guatemala No. *77984;* Dept. Retalhuleu: Vicinity Retalhuleu, alt. 240 m. Coll. Paul C. Standley, Standley Field Expedition of Field Museum of Natural History, Plants of Guatemala No. *88603.*

5. **Farysia venezuelana** Zundel, sp. nov.

Sori infecting and destroying most of the inflorescence, globose, spore-mass black interspersed by numerous elaters; spores globose to subglobose, rarely ellipsoidal, regular, reddish-brown, chiefly 7.5–10.5 μ diameter, thickly verruculate.

Soris inflorescentiam inficientibus et paene perdentibus, globosis, massa sporarum nigra et multis elateribus ut dicunt distincta; sporis globosis vel subglobosis, rare ellipsoideis, regularibus, rubro-brunneis, plerumque 7.5–10.5 μ diam., dense verruculatis.

Hab. in *Carice* sp.

On *Carex* sp., along high mountain road from Caracas toward Colonia Tovar, Venezuela. Coll. H. H. Whetzel and A. S. Müller, March 12, 1939, Exper. de Agric. y Zootecnia. No. *3015.*

Fig. 2. *A, Mycosyrinx Cissi* (D. C.) G. Beck on *Cissus sicyoides,* Central America. Photo by Kribs. *B, Sorosporium Lindmanii* Zundel. Type. Photo by Kribs.

6. Thecaphora Haumani Speg.

On *Iresine Celosia* L., Dept. Chimaltenango: Finca La Alameda, near Chimaltenango, alt. about 1830 m. Coll. Paul C. Standley, Dec. 11–22, 1940, Stanley Field Expedition of Field Museum of Natural History, Plants of Guatemala No. *79914.*

7. Sorosporium Lindmanii Zundel, sp. nov.

Sori destroying the inflorescence, long, linear, 15–18 cm. long, 5–7 mm. wide, at first partially protected by the leaf sheath, cov-

ered by a yellowish-white false membrane which flakes away revealing a dark brown, powdery spore-mass intermixed with long elater-like shreds; sterile cells of the false membrane in chains, hyaline, oblong and flattened on the side of contact, usually giving a cuboid appearance, chiefly 9–14 μ long, thick epispore; spore-balls globose to oblong, many spored, opaque, semi-permanent, dark-brown, 40–90 μ long; spores globose to subglobose, regular, light reddish-brown chiefly 4–7 μ diameter, smooth.

Soris inflorescentiam perdentibus, longis, linearibus, 15–18 cm. longis, 5–7 mm. latis, primum in vagina foliorum partim celatis atque membrana falsa fusco-albaque tectis, quae membrana in squamas rupta atro-brunneam massam sporarum longis et elateroideis pannulis commixtam detegit; cellulis falsae membranae sterilibus et in catenas dispositis, hyalinis, oblongis et latere contingente obtusis, plerumque cubicis, maxime 9–14 μ longis, episporio crasso; massa sporarum globosa vel oblonga, sporis numerosis, opaca, semi-permanente, atro-brunnea, 40–90 μ longa; sporis globosis vel subglobosis, regularibus, lucide rubro-brunneis, plerumque 4–7 μ diam., levibus.

Hab. in *Oplismenopide najada* (Hack. et Arch.), etc.

On *Oplismenopis najada* (Hack. & Arch.) Parodi (*Panicum najadum* Hack. & Arch.), in the forest on the banks of the river Riacho Mbopi, Paraguay. Coll. Nov. 19, 1893, by C. A. M. Lindman. Herb. Brazil, Regnell. Mus. bot. Stockholm, Exped. 1mae Regnellian Fungi No. *B331*.

This specimen was collected by C. A. M. Lindman in Paraguay in 1893. O. Juel reported it as *Ustilago* sp. in "Die Ustilagineen und Uredineen der ersten Regnellschen Expedition, Bihang till K. Svenska Vet-Akad. Handl. Band 23, Afd. III. No. 10, Stockholm 1897 and says "In der Inflorescenz eines unbestimmten Grases. Paraguay, in silvula riparia Riacho Mbopi." Mrs. Agnes Chase kindly identified the host as reported here.

TWO MISCELLANEOUS SMUTS FROM NEW GUINEA AND THE PHILIPPINE ISLANDS

1. Sphacelotheca Polliniana Zundel, sp. nov.

Sori usually destroying all of the ovaries, long, linear, 2–3 cm. long, at first covered by a dark brown fragile membrane which disintegrates exposing a dusty spore-mass surrounding a simple columella; sterile cells about the size of the spores, tinted brown, chiefly in twos or chains, globose, irregular; spores globose to subglobose, regular, olivaceous-brown, chiefly 11–14 μ diameter, smooth.

Soris plerumque ovaria perdentibus, longis, linearibus, 2–3 cm. longis, primum membrana atro-brunnea et fragile coopertis, membrana disintegrans massam sporarum pulverulentam simplici columellae circumstantem exponit; cellis sterilibus eandemque fere magnitudinem atque sporae habentibus, brunneis, plerumque binis vel catenatis, globosis, irregularibus; sporis globosis vel subglobosis, regularibus, olivaceo-brunneis, plerumque 11–14 μ diam., levibus.

Hab. in *Pollinia leptostachyde* Pilger, etc.

On *Pollinia leptostachys* Pilger, Morobe, Kajabit Mission, New Guinea. Flora of New Guinea, Clements Expedition No. *10633.* Coll. M. S. Clements, August 31, 1939. Mrs. Agnes Chase kindly determined the host.

2. **Sphacelotheca benguetensis** Zundel, sp. nov.

Sori in the ovaries, elongate, about 1–1.5 cm. or more in length, 1 mm. wide, covered by a dark-brown false-membrane of sterile cells which disintegrate apically exposing a semi-powdery sporemass surrounding a simple columella; sterile cells chiefly in twos, about the same size as the spores, tinted yellowish-brown; spores subglobose to broadly ellipsoidal or sometimes triangular, irregular and frequently angular, olivaceous-brown, chiefly 10.5 to 14 μ long, apparently smooth but very minutely echinulate under the oil immersion.

Soris in ovariis oblongatis ca. 1–1.5 cm. plus minusve longis, 1 mm. latis, falsa membrana atro-brunnea tectis ex cellulis sterilibus in apice dissolventibus et massam sporarum semi-pulverulentam exponentibus simplici columellae circumstantem; cellulis sterilibus plerumque binis eandem fere magnitudinem ac sporae habentibus, subflavo-brunneis; sporis subglobosis vel late ellipsoideis vel interdum triangularibus, irregularibus et saepe angularibus, olivaceo-brunneis, plerumque 10.5–14 μ longis, apparenter levibus sed minute echinulatis sub oleo ut dicunt immersis.

Hab. in *Themeda triandra* Forsk., etc.

On *Themeda triandra* Forsk., Benguet subprovince, Luzon, Philippine Islands. Coll. E. D. Merrill, May 1911. Flora of the Philippine Islands No. *7908.*

The specimen used for the above description was borrowed from the Bureau of Science, Manilla, P. I. It was labeled *Ustilago bursa* Berk., Det. Sydow. Upon request Dr. G. C. Ainsworth of the Imperial Mycological Institute, Kew has kindly furnished the writer a description and a good drawing of *Ustilago bursa* based on an examination of the type specimen at Kew Gardens. It was found that the Philippine Island specimen did not agree with the

description of *U. bursa* and it is therefore described as a new species.

Recently two new genera of the Ustilaginales have been described in rather inaccessible publications. Therefore, the original descriptions are included in this paper, together with the original illustrations, in order to make them accessible to more workers.

In 1939, Kochman of Poland succeeded in germinating the spores of *Thecaphora leptideum* (Sydow) Zundel and found that the promycelium and sporidia were of a type hitherto undescribed. Based on the type of germination he proposed a new genus of the family Tilletiaceae with the following descriptions:

GLOMOSPORIUM J. Kochman, Acta Soc. Bot. Poloniae **16**: 57–58. 1939. Ill.

Sporae in glomerulos rotundatos conglobatae, promycelium unicellulare, sporidia elliptica, subarcuata, terminalia 3–4 gerens.

GLOMOSPORIUM LEPTIDEUM (Syd.) Kochman. *Tolyposporium leptideum* Syd., Ann. Myc. **11**: 365. 1913. *Thecaphora leptideum* Zundel, Mycologia **29**: 583. 1937.

Diagnosis fructificationi. et sporarum cf. Sydow l. c. sed glomeruli maiores: 33–65 μ diam. et usque 95 μ longi.

Germinatio e promycelio unicellulari 12.5–15 μ crasso et circa 40 μ longo. Sporidia terminalia, elliptica, attenuata, subarcuata 4.5 μ crass. et 12.5 μ long., utrinque 11–12 spiculis longis praedita.

Hab. in ovaries of *Chenopodium album*, France, Germany, Poland, Hungary, Czechoslovakia, Latvia. *Chenopodium striatum* × *opulifolium*, France. *Chenopodium ambrosioides*, Australia.

In 1936 N. N. Lavrov of the University of Tomsk, Siberia, U. S. S. R., described a new genus of the family Ustilagineae and named it *Tranzschiella* in honor of the veteran Russian mycologist W. H. Tranzschel. This genus must not be confused with the rust genus *Tranzschelia* Arthur. Through the courtesy of the Imperial Mycological Institute, Kew, Surrey the original description and illustrations have been secured.

TRANZSCHIELLA Lavrov, Travaux de l'Institut Scientifique de
   Biologie d'Universite de Tomsk 2: 29.   1936.

Characteres fere Ustilaginis. Chlamydosporis opposite vel ad angulis
cellulis arcte adnatis pusillis auctis; promycelio (phragmobasidia) in aqua
pluvia nato hyalino, filiformi, septato; ramulis filiformibus in sporidiolam
comminutis; sporidiolis elongatis, subhyalinis, levibus.
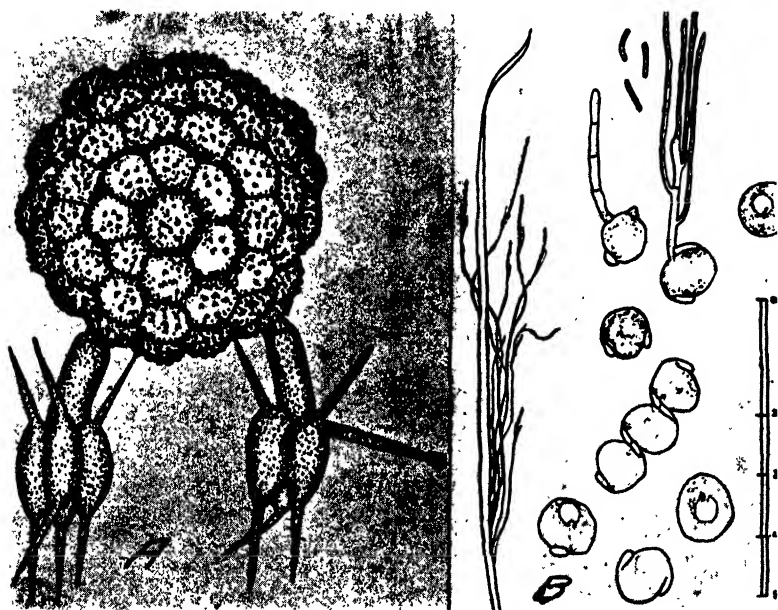
FIG. 3.   *A, Glomosporium leptideum Kochman.*   Germinating chlamydo-
spore.   After the original.   Photo by Hill & Grove.   *B, Tranzschiella oto-
phora* Lavrov.   After the original.   Photo by Kribs.

TRANZSCHIELLA OTOPHORA Lavrov, Trav. Inst. Sci. Biol. Univ.
   Tomsk 2: 29.   1936.

Sporis primo compactiusculis, tunica candida vestitis, dein erumpentibus,
pulverulentis, atro-olivaceis, in culmis, glumellis, ovariis incolentibus; sporis
6–10 micr. diam. obscure-brunneis vel brunneo-olivaceis subglobosis, ellip-
soideis vel rotundato-angulatis, sublevibus, 0.45–0.6 micr. cras. tunicatis, op-
posite vel ad angulos cellulis arcte adnatis pusillis hyalinis, 3–4 micr. long.
1–2 micr. crass. auctis; promycelio (phragmo-basidia), in aqua pluvia nato,
hyalino, filiformi, 4-cellulari, 20–25 × 2–2.5 micr.; ramulis filiformibus, poly-
cellularibus, 40–70 × 1.25–0.85 micr. in sporidiolam oidiiforme comminutis;
sporidiolis elongatis 6–4 × 1.25–0.85 micr., subhyalinis, levibus.

Habitat in parte superiore caulis, in ovariis glumellisque *Stipae pennatae* L. (typice), nec non *Stipae barbatae* Desf., *Stipae Lessingianae* Triu, et Rupr., *Stipae capillatae* L. in Steppis Sibiriae orientalis occidentalisque, Asiae centralis et Tauriae.

Species haec nostra *Tranzschiellae appendiculatae* (Speg.) Lavr. comb. nov. (Syn. *Ustilago? appendiculata* Speg. 1909) proxima, sed area geographica et dimensione sporarum paulum diversa.

NOTES ON THE POTATO SMUT

Polysaccopsis Hieronymi (Schröt.) P. Henn., Hedwigia Beib. 37: 206. 1898.

Syn. *Urocystis Hieronymi* Schröt., Hedwigia 35: 218. 1896.

This potato smut attacking species of *Solanum* in various parts of South America seems to be rather rare so far as can be judged from available records. Large galls develop on the stems, berries, and leaves and it was first described by Schröter as a *Urocystis* as follows:

"Soris in ramulis vel pedunculis, et bullam curvatam, c. 3 cm. longam, 1½ cm. crassam efformantibus, cuticula c. 1 mm. crassa, ochraceo, rugulosa tectis; glomerulis ellipsoideis, 22–40 × 22–30 μ; sporis centralibus singularibus, globosis vel ellipsoideis, 16–26 × 15–20, episporis, castaneo, levi; sporis periphericis 7–12 × 6–8 μ, pallide brunneis. Bolivia auf der Cuesta Zwischen Santa Rosa und Carapari in Stielen von Solanum sp. 17–18 June 1873. G. Hieronymus u. P. G. Lorentz."

From an examination of available material the following description has been written:

Polysaccopsis Hieronymi (Schröt.) P. Henn.

Sori as large irregular gall-like swellings on the stems, young branches and in the leaves, 3–5 cm. long, 1.5–2.5 cm. wide, covered by a thick yellowish membrane which soon ruptures exposing a granular spore mass which is produced in numerous sac-like cavities formed by the mycelium; spore balls globose to ellipsoidal or angular, often irregular in shape, chiefly composed of one central fertile spore and a continuous layer of sterile peripheral cells; chiefly 28–41 μ diameter; spores globose to ellipsoidal or irregular, chestnut brown, chiefly 22–26 μ long, smooth; sterile cells globose to ellipsoidal, firmly pressed together, forming a continuous layer around the central spore, tinted brown to almost hyaline, chiefly 9–13 μ long, smooth.

Fig. 4. *Polysaccopsis Hieronymi* (Schrot.) P. Henn. on *Solanum* sp. Brazil. *A, C, D,* sori on the stems, leaves and berries; *B,* cross section of a sorus on a stem showing the small cavities full of spores. Photo by Viegas.

On *Solanum* sp.: Argentina, Bolivia, Brazil.

The illustrations of the potato smut were kindly furnished by Prof. A. P. Viégas, Instituto Agronomico do Estado de São Paulo, Campinas, Brazil.

NOTES CONCERNING THE GENUS MELANOPSICHIUM

In 1881 Spegazzini described from Argentine Republic a new species of the Ustilaginales on *Polygonum acre* L. to which he gave the name *Ustilago austro-americana* (Anal. Soc. Ci. Agrent. **12**: 63. 1881) together with the following description—

"Soris hypodermici primo bulloso-prominuli, suborbiculares, parvuli (0.2–0.5 diam.) saepius confluentes, matricem irregulariter contorto turnefactam efficientes, dein erumpentes, udi difluenti—visciduli, sicci compacti, tenaces, duri, aterrimi, opaci; sporae globosae, v. irregulariter ovato-ellipticae, episporio crassiusculo levissimo, amoene fuligineo—sub—violaceae (10–14 ×8–11), strato mucoso obovolutae!"

About this time a similar smut on *Polygonum* sp. was found in the Mississippi valley which was considered to be the same species as the one described by Spegazzini. In 1881, Seymour collected this smut in Illinois. Burrill studied it and gave it an unpublished herbarium name viz. "*Ustilago notabilis* Burrill, on *Polygonum pennsylvanicum*, Bluff Lake, Union Co. Oct. 26, 1881, Coll. A. B. Seymour—Illinois Fungi, Herb. State Laboratory of Natural History No. *2012*." This is a true *Melanopsichium pennsylvanicum* as described later. It was later collected by Rev. C. H. Demetrio at Perryville, Missouri, September 1885, and issued in exsiccati as Rab.-Winter, Fungi Eur. *3501* with the following information, "Rabenhorst-Winter, Fungi europaei, *3501*. *Ustilago austro-americana* Spegazzini, Fungi Argentini IV, Pug. 19, America borealis: prope Perryville, Missouri. In foliis, petiolis, praecipuc autem ad perigonia *Polygonii incarnati* L., September 1885. leg. C. H. Demetrio. Obs. Es wäre sehr zu wunschen, dass diese ausserst interessante Art, die wohl kaum zu *Ustilago* gehört, einer eingehenden Untersuchung unterworfen wurde, wozu nur leider die seit mangelt. G. W." It is to be noted that George Winter doubted that this species belonged to the genus *Ustilago*. Nine years later G. Beck studied the above mentioned exsiccati specimen and decided that it belonged to an undescribed genus to which

he gave the name *Melanopsichium* (Ann. Natur. Hofmus. Wien
9: 122.   1894) using the specimen collected at Perryville, Mis-
souri by Demetrio as the type.

That the above mentioned specimen was wrongly named was
realized by Ellis.   In the Ellis collection now in the New York
Botanical Garden is deposited an unpublished description, appar-
ently in the handwriting of Ellis, of a *Polygonum* smut collected
by B. T. Galloway, 1885 in Boone Co. Missouri, and to which the
herbarium name of *Ustilago indurata* E. & E. is given.   The note
is as follows:

· *"Ustilago indurata* E. & E.

On *Polygonum* sp. Boone Co., Mo.—leg. B. T. Galloway.

In the spikes of the inflorescence, forming irregular tubercular
masses ½–1 cm. diam. at intervals along the spike which at these
points is entirely enveloped and transformed into a violet-black,
cavernous mass of spores which seem as if glued together, having
a hard solid texture something like the stick liquorice of the shops
only more brittle, almost carbonaceous.   Spores subhyaline at first
and small (4–6 μ), becoming dark and either globose, 8–12 μ diam.
or subelongated, 14–18 $\times$ 7–10 μ, surface deeply tuberculose-re-
ticulated.

Ustilago austro-americana Speg. has a similar habitat but the
spores are *smooth*.   Dr. Farlow in Bot. Gaz. VIII, p. 278 doubt-
fully refers specimens collected in Iowa by Prof. C. E. Bessey, on
Polygonum (*Pennsylvanicum*) and apparently the same as the
Missouri specimens to *U. Bistortarum* D. C. but as far as we can
judge from the specimens of that species in Rabh. F. Eur. *2602*
and in Kunze's Fungi Selecti nos. *530* & *504*, the form above de-
scribed should be specifically distinct.   Specimens of *U. Bistor-
tarum* on *Polygonum Bistorta* from the Pacific coast agree per-
fectly with the European specimens, the mass of spores being not
at all indurated but loose and dusty and the spores themselves are
merely papillose."

It is thus to be seen that Ellis did not consider the smut de-
scribed by Spegazzini as the same one found in the Mississippi
valley.   He noted the smooth spores of the Spegazzini smut and

the echinulate spores of the smut collected by Demetrio and Galloway.

G. P. Clinton published the first monograph of the "North American Ustilagineae" in 1904 as a doctorate thesis at Harvard University. He used the name *Melanopsichium austro-americanum* (Speg.) Beck for the North American Smut, basing his conclusion that the *Polygonum* smut in question was the same as the Argentina smut from information received from Spegazzini. In his thesis (Proc. Boston Soc. Nat. Hist. **31**: 397. 1904) he adds the following note "This was first described from South America where it apparently grows more commonly on the leaves than it does here. The writer has not seen specimens from there but sent a specimen to Spegazzini who pronounced it the same as his species. In this country the smut appears to be most common in the Mississippi valley. It has a number of characters, *e.g.*, the hygrophilous manner of shedding its spores and the gelatinous spore envelop that relates it to *Cintractia externa*. The germination has been reported by Norton. (Trans. Acad. Sci. St. Louis, **7**: 229–241. 1896. Illustr.)"

It is difficult to understand how such an error on the part of Spegazzini and Clinton could have been made since Spegazzini originally described the spores of *Ustilago austro-americana* as being smooth while in all of the publications of Clinton he describes the spores of the supposedly same smut in North America as echinulate. This error has recently been corrected by Elisa Hirschhorn (Nota d. Museo de La Plata (Bot. 32.) **6**: 147–151. 1941 Ill.) and two species are recognized. Basing her conclusion from examination of two specimens, from the United States, *e.g.*, Phillipsburg, Kansas, 8/1910, leg. Bartholomew, on *Polygonum pennsylvanicum* and ex. herb. Clinton, 9/1892, Urbana, Illinois on *Polygonum lapathifolium* she names the echinulate spored species, *Melanopsichium pennsylvanicum* Hirschh. with the following description: "Sporis aurantiacis, globosis vel irregulariter, ovato-ellipticis; episporio spinoso; diam. 7–11 μ vel 11–10 × 6–7 μ."

In order to definitely determine if both species exist in North America the writer obtained on loan all specimens labeled *Melanopsichium austro-americanum* (Speg.) Beck, from the Missouri Botanical Garden, Farlow Herbarium, Harvard University, The

New York Botanical Garden, Stanford University, the U. S. Department of Agriculture, Mycological Collections, and the University of California, and this courtesy is acknowledged with thanks. In all, 65 specimens were examined but in several cases duplicates of a given collection were found to be deposited in two or more herbaria.   In such cases the duplicate specimens were examined separately and at a different time.   It was found (1) that all collections made from Wyoming east to the Atlantic Coast had echinulate spores (2) collections made in California and some in Texas had smooth spores.   (3) Available collections from China had finely echinulate spores when under oil immersion, but exsiccati specimens from India had smooth spores.   It was further noted that where the host was *Polygonum pennsylvanicum* the spores were globose to subglobose, chiefly 7–10.5 μ diameter.   Where the host was *Polygonum lapathifolium* there were two types of spores (1) globose to elongate, often irregular, chiefly 10.5–14 μ long, and (2) globose to subglobose, 7–10.5 μ diameter as given for *P. pennsylvanicum*.   All echinulate spores were olivaceous-brown in color but the smooth spores were usually light olivaceous-brown to subhyaline.   On the basis of spore measurements it is proposed to divide *Melanopsichium pennsylvanicum* Hirschh. into a typical species and two varieties as follows:

1. MELANOPSICHIUM PENNSYLVANICUM Hirschh.

Sori as previously described; spores globose to subglobose, olivaceous-brown, chiefly 7–10.5 diameter, echinulate.

On *Polygonum Hydropiper* L.: Illinois.

On *Polygonum lapathifolium* L. (*P. incarnatum* Ellis): District of Columbia, Illinois, Iowa, New York, Missouri.

On *Polygonum pennsylvanicum* L.: Illinois, Indiana, Kansas, Missouri, New Jersey, New York.

On *Polygonum* sp.: District of Columbia, Texas, China.

On *Polygonum virginianum* (L.) Raf.: Missouri.

2. MELANOPSICHIUM PENNSYLVANICUM Hirschh. var. **Besseyanum** Zundel, var. nov.

Sori as previously described; spores globose to elongate-ellipsoidal, olivaceous-brown, chiefly 10.5–14 μ long, echinulate.

On *Polygonum* sp., Ames, Iowa. Coll. C. E. Bessey, 1878. Ex. Herb. C. E. Bessey (Type).

On *Polygonum Hydropiper* L.: District of Columbia.

On *Polygonum lapathifolium* L. (*P. incarnatum* Ellis) : Illinois, Missouri, New York, Wyoming.

An unusual specimen collected at Congers, New York seems to be a second variety. The difference consists in the large pustular sori that develop on the stems instead of in the inflorescence. The following name is proposed and described:

3. MELANOPSICHIUM PENNSYLVANICUM var. **caulicola** Zundel, var. nov.

Sori as large, hard, dark pustules on the stem, 2–3 cm. long, 1–1.5 cm. wide, otherwise as for the species; spores globose to sub-globose, chiefly regular, chiefly 7–10.5 μ diameter, rarely 14 μ light olivaceous-brown to subhyaline, echinulate.

On *Polygonum lapathifolium* L. Congers, Rockland Co., New York. Coll. A. David Davies, Oct. 25, 1934 (Cornell Univ. Herb. *23993* also in Farlow Herbarium, Harvard University).

4. MELANOPSICHIUM AUSTRO-AMERICANUM Speg. is distributed as follows:

On *Polygonum aviculare* L.: California (Coll. H. W. Harkness, Herb. W. G. Farlow).

On *Polygonum glabrum* Willd.: India: Pusa (Syd. Fung. exot. *407, 497;* Syd. Ustil. *392*).

On *Polygonum lapathifolium* L.: California (Seal Beach, Calif., Sept. 16, 1936, Com. H. C. McMillan (No. *70914,* U. S. D. A. Myc. Coll. also N. Y. Bot. Gard.; Rio Hondo, Los Angeles Co., Oct. 14, 1832, alt. 190 ft., Herb. Louis C. Wheeler, Flora of California No. *1431*) ; Texas (F. Lindheimer Fasc. IV, 1847–8, Herb. W. G. Farlow).

A LEAF SPOT OF GRASSES CAUSED BY A NEW SPECIES OF PHLEOSPORA [1]

John R. Hardison and Roderick Sprague [2]

(with 2 figures)

During an investigation of the grass diseases occurring in Michigan in 1941, a leaf spot was collected on *Agropyron repens* (L.) Beauv. and *Elymus canadensis* L. caused by a fungus which was tentatively reported as *Phleospora* sp. (2). The infection on *Elymus canadensis* was very light and occurred only on the leaf blades. On *Agropyron repens* the infection was heavy on leaf blades (fig. 1) and extended to the leaf sheaths in some instances. The causal fungus is described as follows:

Phleospora graminearum Sprague & Hardison, sp. nov.

Maculae variabiles, elongatae, brunneae, centro pallidae, margine luteae vel ochraceae. Pycnidia subgregaria, primum immersa, absque ostiolis, brunnea, demum erumpentia, prominentia, ostiolo parvo singulo praedita, subglobosa, diam. maturitate 90–160 μ, superficiei delapsu translucentia, aureilutea; pycnophoris obtusis, brevibus, 3–5 μ latis, hyalinis; pycnosporis obclavatis, chlorinihyalinis apice obtusis, basi rotundatis vel obtusis, variabilibus, 30–55 μ longis, 3.3–5.6 μ latis, 1–6-septatis.

In foliis vivis *Elymi canadensis* et *Agropyri repentis*. Specimen typicum legit J. R. Hardison (41–81) in foliis *Agropyri* prope urbem Ann Arbor, Michigan, Sept. 1941.

Spots variable, elongate, brown, paler in center, margins sometimes yellow or buff colored. Pycnidia subgregarious, at first immersed, non-ostiolate, brown, later erumpent, prominent, with small

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ostiole, subglobose, 90–160 μ, pale brown, upper layer finally breaking away, context translucent and golden colored; pycnophores blunt, short, 3–5 μ wide, hyaline, pycnospores yellow-hyaline obclavate, tapering to a blunt point, base rounded or blunt, variable, 30–55 $\times$ 3.3–5.6 μ, 1- to 6-septate.

FIG. 1. Habit of *Phleospora graminearum* on *Agropyron repens* from the type collection, $\times$ 1½. Photograph by George W. Fisher.

In living leaves of *Elymus canadensis* and *Agropyron repens*. Type specimen in leaves of *Agropyron repens*, Ann Arbor, Michigan, Sept. 1941, John R. Hardison.

Type material has been deposited in the Mycological Collections of the Bureau of Plant Industry, Washington, D. C. (B.P.I. *80,402*) and in the University Herbarium, of the University of Michigan.

In the course of completed but unpublished studies of *Septoria* (3, 6), *Stagnospora* (6), *Phaeoseptoria* (4), *Hendersonia* (7) and *Ascochyta* (5) on Gramineae one of the writers (Sprague) had not seen any fungi on Gramineae,[3] referable to *Phleospora* Wallr. However, this fungus, which is quite distinct from any other sphaeropsidaceous fungus seen on Gramineae, is readily referable to that genus. Grove's discussion of *Phleospora* (1) summarizes the popular concept. It is a genus having pycnidia with relatively
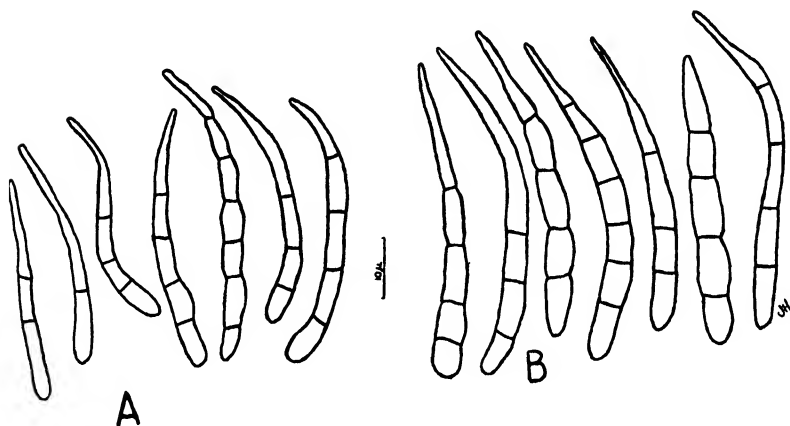
FIG. 2. *A*, pycnospores of *Phleospora graminearum* from the type collection on *Agropyron repens*; *B*, pycnospores of *Phleospora graminearum* on *Elymus canadensis*.

thin apices, which soon burst or evanesce to release a mass of comparatively coarse spores, such as characterize the present fungus (FIG. 2). Diedicke rejected *Phleospora*, placing some of the fungi in *Septoria* and the rest in *Cylindrosporium*. On this basis our specimens would belong in *Septoria*. However, their coarse, broad spores borne in poorly developed pycnidia are atypical for *Septoria* and the obclavate shape of the spores is, incidentally, atypical for *Stagonospora*. The spores are too pale for *Phaeoseptoria*.

Since there appears to be some justification for the genus *Phleospora* and since this fungus definitely answers its require-

[3] These several manuscripts have been or are being submitted for publication but under present conditions will be long delayed in publication. Reference is made to them to indicate a background for study of the *Phleospora* species discussed in the present note.

ments more than that of any other genus, we have referred these collections accordingly.

LITERATURE CITED

1. **Grove, W. B.** British stem- and leaf-fungi 1: 431–432. Cambridge 1935.
2. **Hardison, John R.** Grass diseases in Michigan in 1941. U. S. Dept. Agr., Bureau Plant Ind., Plant Dis. Rep. **26**: 67–75. 1942. (Mimeo.)
3. **Sprague, Roderick.** *Septoria* species on western grasses. In Ms.
4. **Sprague, Roderick.** The genus *Phaeoseptoria* on grasses in the western hemisphere. In Ms.
5. **Sprague, Roderick & Johnson, A. G.** Species of *Ascochyta* on Gramineae in the western United States. In Ms.
6. **Sprague, Roderick.** *Septoria* and *Stagonospora* species on *Agropyron, Elymus* and *Triticum.* In Ms.
7. **Sprague, Roderick.** Notes on *Hendersonia* species on western grasses. In Ms.

ASSOCIATION OF THRIPS WITH POWDERY MILDEWS

C. E. YARWOOD

On July 3, 1942, it was observed that mildewed leaves of Carignane grapes growing in an experimental field plot at Albany, California, were frequently infested with thrips while mildew-free leaves usually showed no thrips. On lightly mildewed leaves any thrips present were usually on the mildew colonies. Lightly mildewed leaves usually had fewer thrips than heavily mildewed leaves, but leaves on which the mildew mycelium was dead usually bore no thrips. The thrips were usually on the lower (dorsal) leaf surface. Several field counts of thrips were therefore made with results as follows:

Date, location, fungus and host	Number of leaves examined	Average number of thrips per leaf	
		Healthy leaves	Mildewed leaves
July 3, Albany, *Uncinula necator* on grape	28	0.15	4.0
Aug. 13, Albany, *Uncinula necator* on grape	25	0.25	0.95
Aug. 17, Santa Rosa, *Uncinula necator* on grape	48	0.0	0.04
Aug. 30, Fairfax, *Uncinula necator* on grape	6	0.0	0.25
Sept. 2, Albany, *Uncinula necator* on grape	10	0.0	2.0
Sept. 2, Santa Clara, *Uncinula necator* on grape	14	1.0	0.8
Sept. 5, San Pablo, *Uncinula necator* on grape	4	0.0	0.5
Sept. 19, Albany, *Sphaerotheca pannosa* on rose	49	0.08	0.8
Sept. 19, Albany, *Sphaerotheca humuli* on strawberry	19	0.11	2.4
Sept. 19, Albany, *Erysiphe Cichoracearum* on cantaloupe	11	—	1.2

In addition, thrips were observed in association with powdery mildew of clover, *Erysiphe Polygoni,* and powdery mildew of *Oenothera, Erysiphe Polygoni,* near Wright's Lake, El Dorado County, on October 4, 1942, though no counts were made. However, field observations in 3 locations of unidentified grape varieties with hairy lower leaf surfaces revealed no thrips on healthy or mildewed leaves.

While most observations were made at Albany and most thrips were collected there, the association of thrips with powdery mildews in other localities indicates that the phenomenon may be of wide-spread occurrence. As observed in the field the mildew appeared normal to the unaided eye, and no controlling effect of the thrips on the powdery mildew as a plant disease was apparent. Nor was the powdery mildew apparently responsible for an economically important occurrence of thrips or thrips injury.

Thrips from the Carignane grapes at Albany were identified as *Thrips tabaci* Lind. by Dr. Stanley Bailey of the Division of Entomology. Other collections of thrips in association with powdery mildews on other hosts appeared to be similar in general appearance. This species is known to be rather omnivorous in its feeding habits. Larvae and adults were present on the mildewed leaves.

Mildewed grape and rose leaves bearing thrips were brought to the laboratory and placed on 10 per cent sucrose solution in petri dishes. Many thrips disappeared from such cultures but some remained active for as long as 8 days. New thrips larvae also appeared on these leaves, presumably from eggs which had hatched after the leaves were brought in. The feeding of the thrips on the mildewed leaves was observed by means of dark field illumination at a magnification of 200 diameters. Actual ingestion of fungus material was not determined but after a thrips moved over a mildewed area, mechanical damage to prostrate hyphae was observed and the motion of the insect's head indicated that it was actively feeding on the fungus.

The mildew on detached rose leaves bearing no thrips and to a lesser extent on grape leaves, developed luxuriantly in the dish cultures and produced an abundance of conidia, but mildew colonies on leaves bearing thrips developed poorly, and if the number of thrips was sufficient the mildew was killed, as judged by the absence of turgid mycelium. In one case one thrips apparently killed one rose mildew colony of about 6 mm. diameter in 3 days. In no case was all the mildew mycelium devoured by the thrips, and this would hardly be expected from an insect with rasping and sucking mouth parts. Some of the damage to the mildew colonies may have been due to the secretions of the insect and to injury caused by the insect walking through the colonies.

To further determine by cultural means the nature of the association between thrips and mildew, thrips from mildewed leaves of grape and rose were transferred to thrips-free healthy and mildewed leaves of grape, rose, bean, and cucumber. The thrips tended to remain associated with the mildewed leaves to a greater extent than with the healthy. In one test 16 thrips were transferred with a brush from mildewed grape leaves to mildew-free rose leaves in petri dishes on 10 per cent sucrose and 16 were transferred to mildewed leaves of approximately the same age in another set of dishes. Three days later only one thrips was found on the healthy leaves while there were 5 on the mildewed leaves. In another test of the same type 7 out of 14 transferred thrips were found on healthy rose leaves after 3 days and 25 out of 25 transferred thrips were found on mildewed leaves. In a third test healthy and mildewed rose leaves were placed in contact with each other in the same dishes. Eight thrips were transferred to healthy leaves and 10 to mildewed leaves. Three days later there were 2 thrips on the healthy and 16 on the mildewed leaves.

Thrips transferred from field grape leaves to healthy or mildewed rose leaves in petri dishes seemed to thrive as well as thrips from rose leaves transferred to rose, but in one test thrips from grape did not remain in such large numbers on healthy and mildewed leaves of bean and cucumber in dish cultures, as on grape and rose leaves.

SUMMARY

Thrips tabaci has been observed associated with powdery mildew infections on grape, rose, strawberry, cantalope, clover, and *Oenothera*. In dish cultures thrips transferred to mildewed leaves of grape and rose thrived better than those transferred to healthy leaves. The thrips appeared to feed on and destroy established mildew colonies on rose and grape leaves, but were present in such small numbers under field conditions as to be of no apparent economic importance.

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THE EFFECTS OF CERTAIN SUGARS AND AMINO ACIDS UPON THE RESPIRATION OF ALLOMYCES [1,2]

FRED T. WOLF AND C. S. SHOUP

Studies involving the nutritional requirements of aquatic fungi, based on growth experiments, have been carried out with numerous representative species (Volkonsky, 1932–33; Stüben, 1939; Schade, 1940; Moreau & Moreau, 1940; Emerson, 1941). Only a few workers, however, have made use of respirometer techniques for testing the respiration of a particular pure substrate as determined by an effect on the oxygen consumption.

In the case of *Leptomitus lacteus,* studied by Schade and Thimann (1940), 1-leucine and d, 1-alanine were found to support growth of this fungus and to cause an increase oxygen consumption by the mycelia as determined by use of Warburg respirometers. Although these amino acids were apparently both respired and utilized in growth by *L. lacteus,* evidence has accumulated that some organisms may respire nutrient substances and yet be unable to employ them in growth (Tamiya, 1932). Furthermore, it is possible that after conti.ued contact with originally unassimilable or inactive nutrient materials, alteration in metabolism may occur through adaptive enzyme action such as that described for yeast and bacteria by Karström (1930), Stephenson and Yudkin (1936) and Stephenson and Gale (1937). The present study is concerned only with the immediate or initial effect of a particular sugar or amino acid upon the oxygen consumption of *Allomyces.* The time during which the cells are in contact with the nutrient materials is insufficient for cell multiplication and adaptation by natural selec-

tion or adaptation induced by the chemical environment. The effects shown should therefore depend upon the nature of the constitutive enzymes of each species studied. Although the question as to whether the substrate is actually utilized in growth cannot be settled by respirometer experiments of short duration, the substrates which stimulate metabolism of starved mycelia should be strongly suspected of supporting growth, a point to be determined through additional investigation.

Allomyces is a genus of phycomycetous fungi belonging to the Order Blastocladiales. Its members are typically aquatic although they are also well known from terrestrial habitats. At least four well-defined species of *Allomyces* are recognized in recent taxonomic accounts of the genus (Indoh, **1940**; Wolf, **1941**; Emerson, **1941**). *A. arbuscula* and *A. javanicus* (belonging to the subgenus *Euallomyces* of Emerson) are long-cycled forms with a life cycle characterized by the alteration of an asexual and a sexual generation. *A. moniliformis* and *A. cystogenus* (belonging to the subgenus *Cystogenes*) are species which have a life cycle consisting of but one obvious generation and involving the formation of cysts (McCranie, **1942**). Thus, fundamental differences in the life cycle exist within the genus.

MATERIALS AND METHODS. One strain of each of these four species, identified as follows, was studied comparatively:

1. *A. arbuscula* Butler (**1911**) em. Hatch (**1933**). The strain used was the isolate "Cuba 2," which has previously been described by Wolf (**1940**).

2. *A. javanicus* Kniep (**1929**). The strain used was the isolate "Florida 2" (Wolf & Wolf, **1941**). This isolate has elongate female gametangia, and is of the type called *A. javanicus* var. *macrogynus* by Emerson (**1941**).

3. *A. moniliformis* Coker & Braxton (**1926**) em. Emerson (**1938**). The strain used was the isolate "Cuba 4" previously described (Wolf, **1940**).

4. *A. cystogenus* Emerson (**1941**). The strain used was Dr. J. V. Harvey's isolate 2261, designated "Arizona 1" in the taxonomic account of Wolf (**1941**). This species is called *A. neo-moniliformis* by Indoh (**1940**).

Stock cultures of the fungi were maintained on boiled hemp seeds, in Petri dishes containing distilled water. A period of about a week from the time of inoculation was sufficient for growth of vigorous and well-developed colonies on this substrate. Only asexual cultures bearing thin-walled and resistant sporangia were used in these experiments; no studies were made of cultures of *A. arbuscula* and *A. javanicus* bearing gametangia.

The experimental procedures were carried out with respirometers of the differential volumeter type developed by Fenn (**1927**) from the original micro-respirometer of Thunberg (**1905**). The instruments used, previously found suitable for measurement of oxygen consumption by bacteria (Shoup, **1929**; Shoup & Kimler, **1934**), consisted of identical glass vessels of 15 ml. capacity connected by means of calibrated capillary tubing in such a manner that when shut off from the atmosphere by stopcocks, a closed system was formed. KOH-wells for absorption of the carbon dioxide produced were sealed within each vessel. Mycelia suspended in a non-nutrient buffer (Sørensen's phosphate) were placed in the experimental vessel with buffer alone being present in equal amount in the control vessel. Consumption of oxygen by the mycelia resulted in the movement of an index droplet of kerosene in the capillary toward the experimental vessel, the rate of movement being taken as a measure of the oxygen consumption. The apparatus was immersed in a large water-bath, and shaken by a motor-driven eccentric. Experiments were performed at temperatures ranging from 15.0° C. to 28.0° C., but the temperature during the course of any single set of experiments of three hours duration remained constant within ± 0.1° C.

When ready for use the mycelia were separated from the hemp seed, washed thoroughly in distilled water and suspended in 1.8 cc. of M/20 Sørensen's phosphate buffer (pH 7.3) within the experimental vessels of the respirometers. Tests were made to determine if there was an effect on respiration rate when mycelia were removed from distilled water to buffer solution but no alteration in metabolism nor change in appearance in the mycelia was noted. Following equilibration for temperature in the water-bath, readings of the oxygen consumption were made at 5-minute intervals during a period of 40 minutes in order to determine the respiration rate

of the mycelia in the non-nutrient medium. At the expiration of this period, 0.2 cc. of M/10 solution of a particular carbohydrate or amino acid was introduced into both the control and experimental vessels. Then, with a final concentration of the nutrient material of M/100, a second oxygen consumption determination was made using the same mycelia during a similar 40-minute period. In the various experiments, the time elapsing between the end of a control run and the beginning of an experimental run ranged from 10 to 20 minutes.

An effect on respiration due to the substrate was indicated when the rate of oxygen consumption in the experimental run was greater than in the control run on the same mycelial mat. Preliminary trials, in which mycelia were removed from hemp seed and immediately used in such an experiment as described, indicated little or no increase in the respiratory rate over that of the control after addition of any of the respirable substances. This was interpreted to indicate the presence of stored food within the mycelia sufficient to enable metabolism to proceed at the maximal rate. It therefore appeared necessary to starve the mycelia, depleting the food reserves and lowering the respiratory rate, before performing the experiments. For the same reason a similar starvation procedure was used by Schade and Thimann (1940). After an experimental study of the time factor involved in such starvation, it was decided to perform all experiments with mycelial removed from hemp seed and placed in distilled water alone for approximately 7 (i.e., 6–8) days prior to use in a respiration experiment. Transfer of the mycelia from distilled water to non-nutrient buffer solution again had no apparent effect on respiration capacity nor did it cause injury from differences in osmotic values.

Approximately 150 experiments of the type described were performed in the course of this study. These experiments have involved examination of 22 different substrates of suspected physiological importance. Reagents used were analytical grade C.P. chemicals in all cases, from Eastman, Pfanstiehl, or Merck, and were of the highest purity obtainable.

The effect of each substrate was determined upon each of the four species of *Allomyces*. Duplicate confirming determinations for each substrate and each species were made in all cases. The

pH of the mycelial suspensions was determined with the glass electrode and potentiometer following the experiments and indicated no change in hydrogen-ion concentration had occurred. The results, as presented in the accompanying tabulation (TABLE I) thus represent averages of at least two determinations, and are expressed as percentage of increase in rate of oxygen consumption in the presence of a given substrate, in comparison with the rate of oxygen consumption by the identical mycelia when in non-nutrient buffer.

TABLE 1

THE EFFECT OF VARIOUS CARBOHYDRATES AND AMINO ACIDS ON THE OXYGEN CONSUMPTION OF FOUR SPECIES OF *Allomyces*

Results are expressed as percentage of increase over the controls.

Substrate	A. arbuscula	A. javanicus	A. moniliformis	A. cystogenus
Mannitol	0	0	0	0
d-Arabinose	0	0	0	0
l-Arabinose	0	0	0	0
Glucose	0	0	0	0
Levulose	0	0	0	0
Galactose	0	0	0	0
Maltose	40	0	0	0
Lactose	0	0	0	0
Sucrose	40	0	0	0
Cellobiose	0	0	0	0
Dextrin [3]	75	45	100	100
Soluble Starch [3]	0	0	0	0
Peptone [4]	150	300	60	45
Glycine	0	0	0	0
Alanine	50	0	60	20
Leucine	105	0	0	0
Aspartic acid	15	25	120	100
Asparagin	80	0	0	0
Glutamic acid	55	100	170	60
Cystine	30	40	0	0
Arginine-HCl	160	45	0	0
Tyrosine	0	0	0	0

DISCUSSION. It may be recalled that but a single strain of each species has been studied, hence there exists the possibility that the results may be characteristic of these particular strains only, and not of the species in general. Nevertheless, certain conclusions seem warranted. It is evident first of all, from the results pre-

[3] The concentration used was M/100 on assumption that $n = 1$ in the formula $(C_6H_{10}O_5)_n$.

[4] The concentration used was 1 per cent.

sented in Table 1, that peptone, dextrin, aspartic acid, and glutamic acid are respired by all four strains of the species of *Allomyces* under consideration, whereas eleven of the substrates tested, namely; mannitol, d-arabinose, l-arabinose, glucose, levulose, galactose, lactose, cellobiose, soluble starch, glycine, and tyrosine are not respired by any species of *Allomyces*, under the experimental conditions employed. In general, therefore, all of the species appear capable of respiring a greater variety of amino acids than of sugars. It may be assumed therefore and appears probable that in nature proteins and their degradation products furnish the greater part of their food. Carbohydrates do not appear to be of outstanding significance in the respiration of these fungi.

The remaining substrates (maltose, sucrose, alanine, leucine, asparagin, cystine, and arginine-HCl) are respired by one or more of the species of *Allomyces,* but not by all. It is evident that the four species under consideration show differences in their respiratory capabilities. Emerson and Fox (**1940**) noted differences in growth of certain species on oatmeal agar and "Yp. Ss. agar" (powdered yeast extract, soluble starch and inorganic salts). From their results the inference may be drawn that differences in respiratory powers exist, a conclusion that finds support in the present experiments.

A. arbuscula is capable of respiring a greater variety of nutrient materials than does any one of the three other species. Eleven of the substrates tested (maltose, sucrose, dextrin, peptone, alanine, leucine, aspartic acid, asparagin, glutamic acid, cystine, and arginine-HCl) are respired by *A. arbuscula,* six by *A. javanicus,* and five by *A. moniliformis* and *A. cystogenus.*

It is perhaps significant in this connection that *A. arbuscula,* on the basis of existing evidence, appears to be by far the most common and widely distributed of these species. This conclusion follows from the isolation work of Emerson (**1941**). Of at least 149 isolates listed by him as belonging to these four species, 125, or 84 per cent of the total, is composed of *A. arbuscula.* Of 52 isolates belonging to these four species studied by Wolf (**1940, 1941, 1941a**), 42, or 81 per cent of the total is *A. arbuscula.* These lines of evidence lead to the conclusion that there is a direct relationship between the ability of this species to respire a wider

variety of materials, under laboratory conditions, and its greater abundance in nature. Conversely, the more specialized requirements of *A. javanicus, A. moniliformis,* and *A. cystogenus* may plausibly have operated as limiting factors in the less frequent occurrence (or at least less frequent collection) of these species in nature.

Of the six substances known to be respired by *A. javanicus* or to stimulate its metabolism, each is also active upon *A. arbuscula.* On this basis there would appear to be a considerable degree of physiological similarity between the two species. It is at least an interesting coincidence that *A. javanicus* and *A. arbuscula* also have similar life cycles involving an alternation of asexual and sexual generations.

A. moniliformis and *A. cystogenus* have each been shown to respire and perhaps to utilize five of the 22 substances tested. No substance respired by one is not also respired by the other, indicating that these two species could be regarded as physiologically similar. All of the substances, with the exception of alanine, respired by them are also respired by both *A. arbuscula* and *A. javanicus.* Inasmuch as *A. moniliformis* and *A. cystogenus* have identical life cycles involving but a single obvious generation with subsequent cyst formation, and differ from *Euallomyces* in this respect, the existing taxonomic arrangement of the genus finds some degree of substantiation on physiological grounds. It would thus appear that the two species groups have somewhat characteristic constitutive enzyme systems responsible for increased oxygen uptake in the presence of the various substances.

SUMMARY

This study involves the use of oxygen consumption measurements, made by means of the Fenn differential volumeter, to determine the ability of four species of *Allomyces* (*A. arbuscula, A. javanicus, A. moniliformis, A. cystogenus*) to respire certain nutrient substances. Twenty-two different carbohydrates and amino acids were employed with each species.

Peptone, dextrin, aspartic acid, and glutamic acid were respired by all four species of *Allomyces,* whereas mannitol, d-arabinose,

l-arabinose, glucose, levulose, galactose, lactore, soluble starch, cellobiose, glycine and tyrosine were not respired by any of the species.

Differential results were obtained in experiments with maltose, sucrose, alanine, leucine, asparagin, cystine, and arginine-HCl. *A. arbuscula* is capable of respiring eleven of the substrates tested, *A. javanicus* can respire six, and *A. moniliformis* and *A. cystogenus* can respire five each.   In an interpretation of these findings an attempt is made to correlate the more common occurrence of *A. arbuscula* in nature with its lack of physiological specialization.

The morphological similarities between *A. arbuscula* and *A. javanicus,* and between *A. moniliformis* and *A. cystogenus* appear to be correlated with similarities in respiratory metabolism and in the nature of their constitutive enzyme systems.

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LITERATURE CITED

Butler, E. J. 1911.   On *Allomyces,* a new aquatic fungus. Ann. Bot. **25:** 1023–1024.

Coker, W. C. & H. H. Braxton. 1926. New water molds from the soil. Jour. Elisha Mitchell Sci. Soc. **42:** 139–149.

Emerson, Ralph. 1938. A new life cycle involving cyst-formation in *Allomyces.* Mycologia **30:** 120–132.

——. 1941. An experimental study of the life cycles and taxonomy of *Allomyces.* Lloydia **4:** 77–144.

—— & D. L. Fox. 1940. γ-carotene in the sexual phase of the aquatic fungus *Allomyces.* Proc. Roy. Soc. London. Series B. **128:** 275–293.

Fenn, W. O. 1927. The gas exchange of nerve during stimulation. Am. Jour. Physiol. **80:** 327–346.

Hatch, W. R. 1933. Sexuality of *Allomyces arbuscula* Butler. Jour. Elisha Mitchell Sci. Soc. **49:** 163–170.

Indoh, H. 1940. Studies on Japanese aquatic fungi. II. The Blastocladiaceae. Sci. Repts. Tokyo Bunrika Daigaku, Sec. B. **4:** 237–283.

Karström, H. 1930. Über die Enzymbildung in Bakterien. Thesis, Helsingfors.

Kniep, Hans. 1929. *Allomyces javanicus,* n. sp., ein anisogamer Phycomycet mit Planogameten. Ber. Deutsch. Bot. Ges. **47:** 199–212.

McCranie, James. 1942. Sexuality in *Allomyces cystogenus.* Mycologia **34:** 209–213.

Moreau, F. & Mme. F. Moreau. 1940. Recherches sur les Saprolegniees. Ann. Sci. Nat. II. **1:** 221–358.

Schade, A. L. 1940. The nutrition of *Leptomitus*. Am. Jour. Bot. **27**: 376–384.

—— **& K. V. Thimann.** 1940. The metabolism of the water mold, *Leptomitus lacteus*. Am. Jour. Bot. **27**: 659–670.

Shoup, C. S. 1929. The respiration of luminous bacteria and the effect of oxygen tension upon oxygen consumption. Jour. Gen. Physiol. **13**: 27–45.

—— **& A. Kimler.** 1934. The sensitivity of the respiration of luminous bacteria for 2, 4-dinitrophenol. Jour. Cell. Comp. Physiol. **5**: 269–275.

Stephenson, M. & J. Yudkin. 1936. Galactozymase considered as an adaptive enzyme. Biochem. Jour. **30**: 506–514.

—— **& E. F. Gale.** 1937. The adaptability of glucozymase and galactozymase in *Bacterium coli*. Biochem. Jour. **31**: 1311–1315.

Stüben, Henry. 1939. Über Entwicklungsgeschichte und Ernährungsphysiologie eines neuen niederen Phycomyceten mit Generationswechsel. Planta **30**: 353–383.

Tamiya, H. 1932. Verwendbarkeit von verschiedenen Kohlstoffverbindungen im Bau und Betriebstoffwechsel-physiologie von *Aspergillus oryzae*. Acta Phytochem. **6**: 1–129.

Thunberg, T. 1905. Eine einfache Anordnung um die Sauerstoffzehrung kleinerer Organismen oder Organe zu demonstrieren. Zentralb. Physiol. **19**: 308–310.

Volkonsky, Michel. 1932. Culture de *Saprolegnia* sp. en milieu synthetique. Son alimentation sulfuree. Compt. Rend. Soc. Biol. **109**: 528–530.

——. 1932a. Utilization de differentes combinaisons du soufre par *Saprolegnia* sp. Compt. Rend. Soc. Biol. **109**: 614–616.

——. 1933. Sur les conditions de culture et le pouvoir de synthese de *Saprolegnia* sp. Ann. Inst. Pasteur **50**: 703–730.

——. 1933a. Sur l'assimilation des sulfates par les champignons: euthiotrophie et parathiotrophie. Compt. Rend. Acad. Sci. Paris **197**: 712–714.

Wolf, Fred T. 1940. The genus *Allomyces* in Cuba. Lloydia **3**: 301–303.

——. 1941. A contribution to the life history and geographic distribution of the genus *Allomyces*. Mycologia **33**: 158–173.

——. 1941a. An addition to the fungus flora of Barro Colorado Island. Trans. Brit. Myc. Soc. **25**: 191–193.

—— **& F. A. Wolf.** 1941. Aquatic Phycomycetes from the Everglades region of Florida. Lloydia **4**: 270–273.

DASTURELLA—A NEW GENUS OF UREDINALES

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(with 5 figures)

Among some rusts received at the *Herbarium Cryptogamae Indiae Orientalis* (Imperial Pusa Herbarium) for determination were three collections which cannot be placed in any known genera of the Uredinales. The first two collections are on *Dendrocalamus strictus* Nees and the third on *Bambusa* sp. Pycnia and aecia are lacking but a few uredia and a relatively larger number of·telia are present in all the collections. The pustules are at first subepidermal but they soon rupture the epidermis and lie exposed on the surface of the leaves.

The teliospores are 3- to 6-celled and are united into compact, sessile heads without cysts. The heads bear a superficial semblance to those of *Ravenelia* and *Nothoravenelia* but in the former genus the teliospores are one- or two-celled and the heads are borne on compound, hyaline pedicels. In *Nothoravenelia* the teliospores are two-celled and the heads are sessile but both in this genus and in *Ravenelia* the cysts form a prominent feature of the teliospore-heads. The rusts under study do not belong to either of the two genera.

The species on *Dendrocalamus strictus* agreed, however, with *Angiopsora divina*, which was established by Sydow for a rust on *Bambusa* sp. collected by R. N. Tandon at Majhgawan on January 5, 1935. A specimen of this rust was kindly made available by Dr. Tandon from his collection No. 188, a part of which was made the type of the new species by Sydow (**1936**). The identification of the host as *Bambusa* sp. seems to have been tentative. Dr. N. L. Bor, Forest Botanist, Dehra Dun, thought that the leaves may be of *Dendrocalamus* sp.

The genus *Angiopsora* was established by Mains (**1934**) to accommodate those rusts on grasses whose telia occur as crust-like

masses of cells entirely covered by the epidermis. The telia are arranged in vertical rows up to three to four cells thick in the centre of the sorus. The cells adhere laterally as firmly as vertically but they tend to separate if crushed under a cover glass, indicating that the telia consist of one-celled, catanulate, sessile teliospores.

The adherence of the teliospores into compact crust-like masses, the uniformly palisade-like arrangement of the telia, their being non-erumpent and covered by a persistent epidermis, and the catenulate arrangement of the teliospores, characterise the genus *Angiopsora*. The telia of the rusts on *Dendrocalamus strictus* and *Bambusa* sp. do not form crust-like masses or a palisade-like arrangement; they are erumpent in a very early stage of their growth and vestiges of the epidermal layer, lifted by the developing telial head which emerges as a single solid structure, can be seen surrounding the pustules. The teliospores are fascicled into a cushion-like head with a definite flabelliform shape. These characters preclude the inclusion of the species in that genus. Regarding the teliospores, they do not appear to be one-celled or catenulate. Efforts made to separate the telial columns into individual spores by crushing them have shown that they break above or below the septa and occasionally at the septa. This indicates that the teliospores may be continuous structures, each made up of 3 to 6 cells. They are sessile, arise below in a cellular sheet and thin-walled but the apical wall is very thick. This wall fuses with the similarly thickened apical walls of the other spores, which gives firmness and shape to the head. This rather thick apical wall is a very characteristic feature, which is absent in *Angiopsora*.

The rusts on *Dendrocalamus strictus* and *Bambusa* sp. differ, not only from *Angiopsora* but other known rust genera, sufficiently to warrant the erection of a separate genus for the reception of these species for which the following name, in honour of J. F. Dastur, a distinguished Indian mycologist, is proposed.

Dasturella gen. nov.

Pycnia aeciaque nobis ignota. Uredia primo subepidermalia, deinde erumpentia, paraphysata, sine peridiis; urediosporae apedicellatae. Telia sub-

epidermalia, erumpentia; teliosporae in magnis coloratis, sessilibus caputibus, sine cystidiis, dispositae, utrimque, 2-, 6-, raro 7-locellatae.

Species typica: *Dasturella divina* (Sydow) Mundkur & Kheswalla.

Pycnia and aecia unknown. Uredia minute, at first subepidermal, later erumpent, paraphysate, without peridia; urediospores sessile. Telia subepidermal, erumpent; teliospores fascicled into large, coloured, sessile heads without cysts, 3- to 6-, rarely 7-celled.

Type species: *Dasturella divina* (Sydow) Mundkur & Kheswalla.

Dasturella divina (Sydow) comb. nov.

Uredia hypophyllous, solitary or in small stripes, covered for some time by a raised epidermis, later erumpent, pulverulent, bright brown, surrounded by numerous inwardly curved paraphyses; paraphyses cylindrical to tubular, 45–76 × 8–11 μ, almost hyaline to very slightly yellow; urediospores sessile, almost globose to egg-shaped or ellipsoidal, 18–26 × 15–23, echinulate, wall up to 1.5 μ thick, with 3 to 4 rather indistinct equatorial germ pores. Telia hypophyllous, usually solitary, rarely two or three coalescing, surrounded by a yellowish brown discolouration; subepidermal, erumpent, without paraphyses or peridium; teliospores sessile, arising from a cellular sheet, 59–114 × 8–17 μ, side walls up to 1.0 μ thick, apical wall 3.7 to 11.7 μ in thickness, dark cinnamon brown, 3- to 6-, rarely 7-celled. Germ pores obscure or none.

On leaves of *Dendrocalamus strictus* Nees, Lansdowne (United Provinces) September 1934, leg. P. C. Kanjilal (Type); Saharanpur November 1939, leg. O. S. Madan; on *Dendrocalamus* sp. (nec. *Bambusa* sp.), Majhgawan, January 5, 1935, leg. R. N. Tandon (No. *188,* type of *Angiopsora divina*). Also in Tonkin and Japan.

Type deposited in *Herbarium Cryptogamae Indiae Orientalis* of the Imperial Agricultural Research Institute, New Delhi.

Dasturella bambusina sp. nov.

Uredia hypophylla, minuta, pulverulenta; urediosporac ovoideae vel ellipsoideae, tenuiter echinulatae, flavo-aurantiacae vel pallide flavae, 22–29 × 17–21 μ, germinationis poris 2; paraphysibus intermitis, erectis, cylindraceocapitatis, leviter brunneis. Telia hypophylla, sine peridiis vel paraphysibus, sparse vel aggregata, in maculis nigris foliorum venis parallelis disposita;

teliosporarum capita flabelliformia, 89 to 144 μ alta, 237 to 477 μ diametro; teliosporae sessiles, ex lamina cellulosa, 43–95 × 11–17 μ, eae ex margine superiore crasso apici muro, 4.7–9.3 μ (muri alibi tenues), ex nigro cinna-moneo-brunneae, utrimque 3-, 5-locellatae. Germinationis pori ignoti.
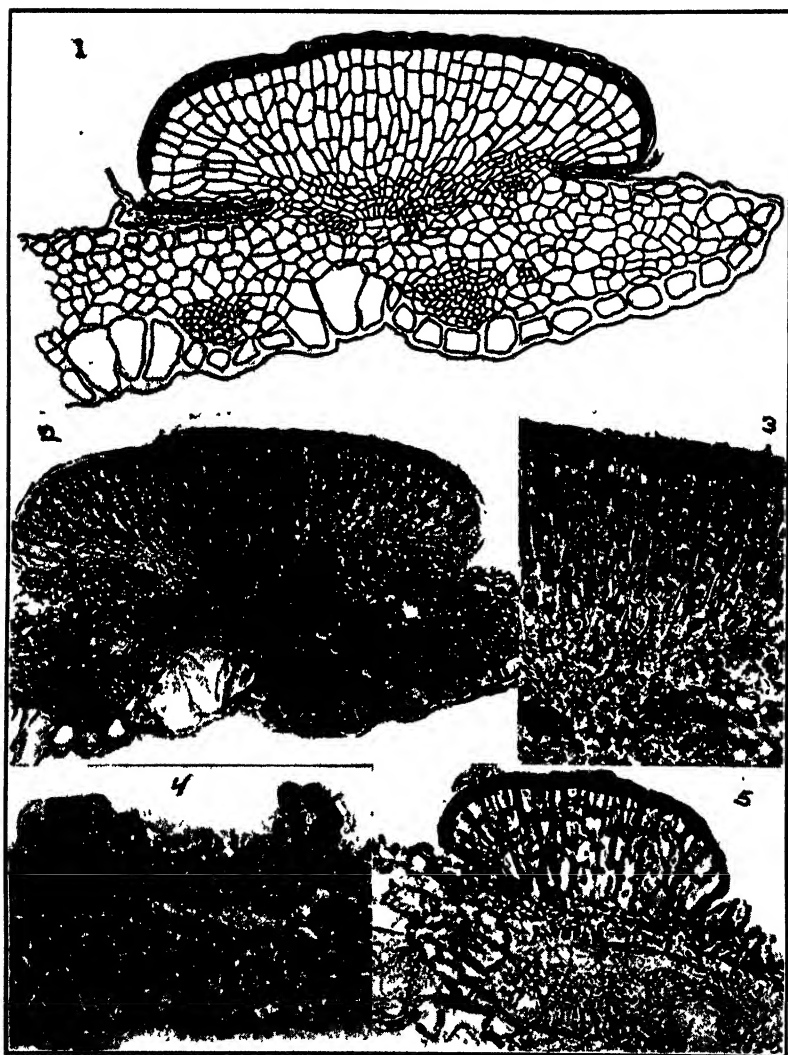
FIGS. 1–4, *Dasturella divina;* 5, *D. bambusina.* Fig. 1, × 296, telial head of *D. divina* (camera lucida); 2, × 225, photomicrograph of same; 3, × 900, part of same more highly magnified; 4, × 225, uredial sorus showing peripheral paraphyses; 5, × 225, telial head of *D. bambusina.*

Hab. in foliis *Bambusae* sp., Mahableshwar, March 18, 1917, leg. S. L. Ajrekar (*Typus*).

Uredia hypophyllous, minute, pulverulent; urediospores ovoid to elliptical, finely echinulate, orange yellow to pale yellow, 22–29 × 17–21 μ, with two germ pores; paraphyses intermixed, erect, cylindrical-capitate, slightly brownish. Telia hypophyllous, without peridia or paraphyses forming rows of black dots parallel to the veins, aggregated or scattered; teliospore-heads flabelliform, 89 to 144 μ in height and 237 to 477 μ in diameter; teliospores sessile, arising from a cellular sheet, 43–95 × 11–17 μ, apical wall 4.7 to 9.3 μ, side walls thin, deep cinnamon brown, 3- to 5-celled. Germ pores not seen.

On leaves of *Bambusa sp.* Mahableshwar, March 28, 1917, leg. S. L. Ajrekar (*Type*). Type deposited in the *Herbarium Cryptogamae Indiae Orientalis*.

The uredia of these rusts do not have a peridium and the urediospores have rather indistinct germ pores at the equator. The teliospores though sessile are not in the form of crust-like masses but are compacted into fan-shaped heads. These characters indicate that the position of the genus is not in the Melampsoraceae but in the Pucciniaceae. The heads are, however, sessible but a genus with sessile heads, *Nothoravenelia,* has already been placed in the Pucciniaceae by Dietel (1928) and other genera with sessile teliospores in the same family are *Chaconia, Desmotelium* and *Olivea;* paraphysate uredia are a feature of *Calidion, Desmotelium* and *Olivea* and even some species of *Ravenelia.* Aside from this, the semblance between the heads of *Dasturella* and those of *Ravenelia* and *Nothoravenelia* secures for the genus a position in the tribe Raveneliae of Dietel's (1928) classification of the Pucciniaceae.

Species belonging to the genera *Puccinia, Uromyces* and *Angiopsora* were alone recorded on grasses, the status of the genus *Diorchidium,* species of which occur on the Gramineae, not being very clear. Recently a species of *Phakopsora* has been reported on grasses by Cummins (1941) *Dasturella* is the fifth genus so far known to occur on the Gramineae, apart of course from the form genera.

We wish to express our thanks to Dr. N. L. Bor, Forest Botanist, Dehra Dun, for his kindness in rendering into Latin the diag-

noses of the new genus and the new species and to Dr. K. Bagchee, Forest Mycologist, and Dr. R. N. Tandon, for placing some of the material at our disposal for study.

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LITERATURE CITED

Cummins, G. B. 1941. Uredinales of New Guinea—III. Mycologia **33**: 143–154.

Dietel, P. 1928. Hemibasidii, in Engler and Prantl's Die Naturlichen Pflanzenfamilien. 2nd Aufl. **6**: 24–98.

Mains, E. B. 1934. *Angiopsora*, a new genus of rusts on grasses. Mycologia **26**: 122–132.

Sydow, H. 1936. Über zwei neue Arten der Gattung *Angiopsora*. Ann. Myc. **34**: 69–73.

A STEM CANKER OF DOGWOOD AND MADRONA

D. E. Stuntz and C. E. Seliskar

(with 6 figures)

INTRODUCTION

Within the last few years trees of Pacific dogwood, *Cornus Nuttallii* Aud. and madrona, *Arbutus Menziesii* Pursh, in and around Seattle have been affected in increasing numbers with a disease which produces girdling cankers on the stems, and eventually kills the trees. Infected trees have been found near Medina, and in Richmond Beach, Washington, and the disease is quite common in the northern residential district of Seattle, where dogwood and madrona are widely used as ornamentals. In the late summer of 1941 numerous dead and dying trees in the Laurelhurst district of Seattle were brought to the attention of the writers by Dr. J. H. Hanley, director of the University of Washington Arboretum, and it was decided to undertake a study of the disease, to determine its cause, and to investigate the possibility of its control. Some of the results obtained thus far form the basis of this article, and other aspects of the problem are under further investigation by the junior author, who plans a more detailed study of the disease.

DESCRIPTION OF THE DISEASE

The first symptoms commonly noted on dogwood and madrona are a browning and thinning of the leaves in the uppermost crown, followed by complete defoliation and death of the tree. The small twigs and branches at the top of the tree die first. Eventually the larger branches and stem also die. The leaves of infected trees in the upper crown are abnormally small, often chlorotic in appearance, and curled at the edges. Following this condition, the leaves turn brown and are shed. If the trees are killed very suddenly during the summer or early fall before the formation of the abscis-
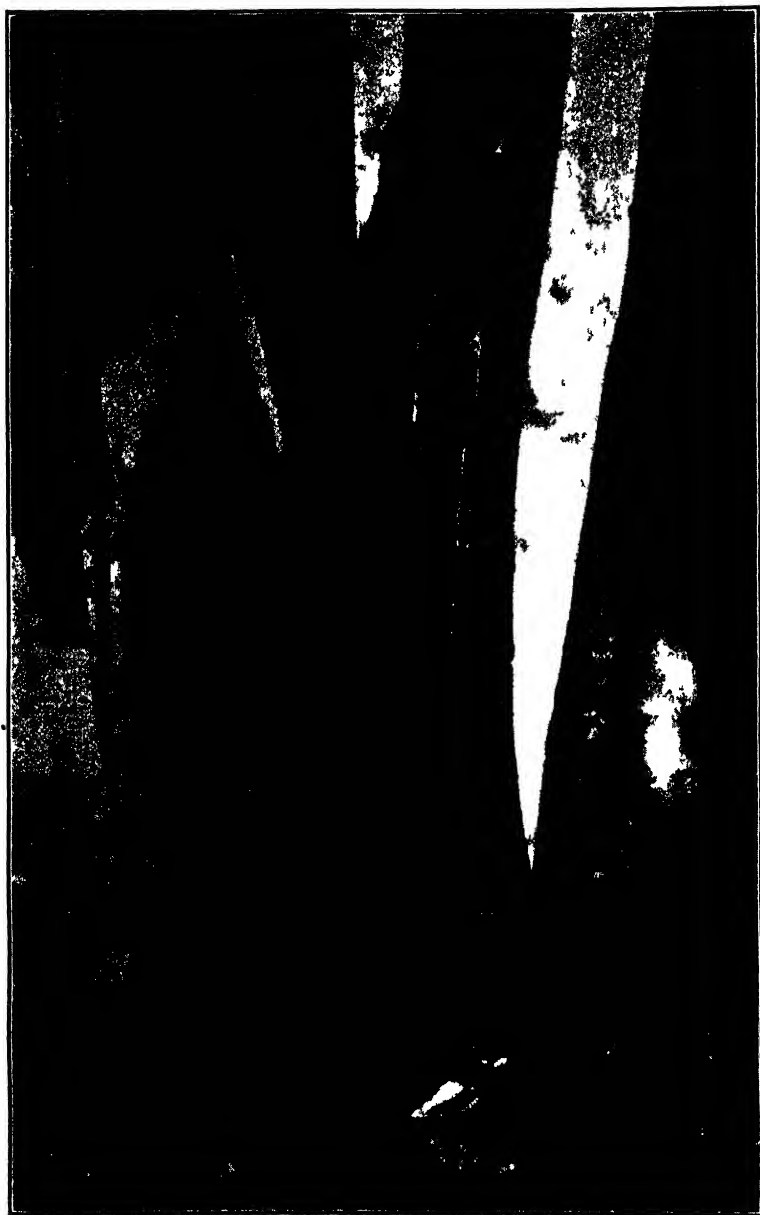
FIG 1. Natural canker on *Cornus Nuttallu* A portion of the surface bark has been removed to show maigin and typical discoloration Note cracking of bark at base of tree.

sion layer, the leaves may remain attached to the twigs long after the normal trees have shed their leaves. Oftentimes the crown will wilt prior to defoliation, particularly during the heat of the summer when transpiration progresses at a fast rate and a sudden interruption of the transpiration stream causes an acute water shortage. This is especially true of madrona, in which the disease is quite virulent.

In both species, the condition of the crown is reflected in a cankerous condition of the stem. In the early stages, the cankers are easily overlooked, particularly on dogwood, where there is little apparent surface discoloration. The presence of a young canker is usually indicated by a sunken or water-soaked bark area. The diseased condition of a stem can be quickly shown by cutting into the inner bark. The infected bark tissue presents a definite discoloration, generally ranging from light brown to a dark or purplish black, as contrasted to the white or cream-colored bark typical of healthy tissue. The differences in discoloration seem to vary with the individual trees. In addition, the outer sapwood is usually discolored, in which case the discoloration may extend to a depth of approximately one or two millimeters. Not infrequently narrow discolored streaks of diseased inner bark and outer sapwood may be found extending some distance beyond the immediate upper and lower margins of the canker. In some cases, these appear only in the outer sapwood and cambium; in others, in both the outer sapwood and inner bark. Although in the early stages the cankers on dogwood are easily overlooked, the young cankers on madrona are readily discernible because of the dark surface discoloration which is very strikingly contrasted to the normal orange-red outer bark.

The canker usually exhibits a definite margin. Following periods unfavorable for the growth of the fungus, this is in the form of a crack between the diseased and healthy tissue. Such a marginal crack usually is found during the winter months. During the periods of vigorous growth, however, the extension of the fungus may not be delimited in this manner. In this case, the margin is very irregular, usually fimbriate and sometimes with small or large finger-like projections (FIGS. 1, 2). Eventually, the dead bark cracks and sloughs off. Oftentimes this is accompanied by a black

Fig 2   Natural canker on *Arbutus Menziesii*   Surface bark has been scraped away to show margin and characteristic blackening of diseased tissues

liquid, composed of decomposition material, which oozes from the cracks. This flow of exudate may also occur in the early stages of infection. Soon after, the older portions of the canker are infested with saprophytic organisms and insects.

In the majority of the cases noted by the writers, the cankers apparently started at or near the base of the stem, probably at the root crown. A few cases were noted where the cankers originated at broken branch stubs, indicating that the infection court is not necessarily limited to the base of the tree. It appears that infection is governed by suitable moisture conditions, such as are found in crotches, at the root crown, and other places where moisture is likely to collect.

The rate of spread of the canker is two to several times greater in a vertical direction than in a lateral direction. Cankers that have originated at the base of the tree assume a broadly conical shape, and several such conical projections may be found on a single stem at the apex of a canker. Cankers originating at some distance above the ground are roughly elliptical in shape. The tree is eventually girdled and dies. When cankers were artificially induced, the vertical spread progressed at a rate of two to three times that of the lateral spread for the first four or five weeks, followed later by a more rapid lateral spread and a somewhat lower rate of vertical spread.

While little is known about the pathological anatomy of the disease, investigations are now under way to obtain a more thorough understanding of the biology. The extent of the invasion zone beyond the margin of the canker was tested experimentally in the laboratory in two different ways. Apples were inoculated with bits of bark tissue obtained adjacent to the margin of a canker produced by the disease. The tissue was taken at one-centimeter intervals beginning at the upper extremity of the margin of the canker and extending in a vertical direction into the seemingly uninfected bark. In a like manner, tissue was removed from points adjacent to the lateral margins of the canker and inoculated into apples. In addition, the same method was used in directly inoculating oatmeal agar slants. The results showed no growth on either the apples or agar from bark tissue except when it was obtained from the immediate margin of the canker.

IDENTITY OF THE PATHOGEN

Small bits of tissue taken from the margin of cankers on both madrona and dogwood were placed on agar slants and incubated at 25° C.   Pure cultures of two obviously different organisms were obtained in many instances.   One of these organisms, later identified as a species of *Phomopsis,* was dismissed from further consideration when inoculations proved it incapable of invading live tissue of either dogwood or madrona.   It is to be regarded as a secondary fungus which invades the diseased areas, and may even coexist with the mycelium of the pathogen at the margin of cankers. The other organism was soon shown, by its mycelial characteristics and production of oögonia and sporangia, to be a species of *Phytophthora.*   Subsequent tests proved it to be pathogenic to both dogwood and madrona (see below).   The necessary data were accumulated for its identification by means of the keys to *Phytophthora* given by Tucker (6) and Leonian (3).   These data are embodied in the description of the fungus given herewith:

Mycelium coenocytic, becoming septate in old cultures, branching profusely in an irregular manner, and bearing an abundance of knobby, wart-like, often fantastically contorted protuberances which may occur in dense, tangled masses.   Oögonia 26.2 × 27.2 μ (average of 32 measurements), spherical to pyriform, borne terminally on short lateral branches (FIG. 3) ; antheridia predominantly paragynous, large, appressed to the base of the oögonium and usually also to its stalk; plainly amphigynous antheridia rather numerous in some mounts, scarce or absent in others.   Oöspores 21.8 μ in diameter (average of 32 measurements), borne singly in the oögonium, spherical, with smooth, thick, refringent, hyaline to pale yellowish wall (FIG. 3).   Sporangia 32.0 × 40.2 μ (average of 28 measurements), thin walled, hyaline, spherical to subglobose or ovoid, with a prominent papilla, attached laterally or basally to the branches of slender, delicate, sympodially branched sporangiophores, from which they readily become detached (FIG. 4).   Germination of the sporangia sometimes by a germ tube, but normally by zoöspores which escape fully formed through the papilla. Chlamydospores infrequently produced, spherical, subglobose or subpyriform, thin walled, not darkening with age, with dense granular contents, closely resembling the sporangia except in their total lack of a papilla.

Abundant growth on oatmeal agar at 20° C.   Vigorous colonies on oatmeal agar at room temperatures (20° C.) in 6 days, with the

Fig. 3. Photomicrograph of mature oögonium with enclosed oöspore
(× 1944). Courtesy of Bror L. Grondal.

Photomicrograph of sporangia (× 1250). Courtesy of
Bror L. Grondal.

production of abundant woolly aerial mycelium, upon which numerous sporangia appear within 7 days; oögonia appearing later (within 14 days) and chlamydospores still later, if at all. Good growth on malt agar at room temperatures, the colonies thin, appressed, with aerial mycelium sparse and poorly developed, oögonia produced after 10 days. Vigorous growth on cornmeal agar in 4 days at 25°–28° C., the colonies widely spreading, but thin and appressed, resembling those produced on malt agar. Sterile mycelium, grown for three days in pea broth, producing an abundance of oögonia within 48 hours after being washed and transferred to sterile water, and giving rise subsequently to numerous sporangia from which fully formed zoöspores are liberated.

From the above data, it is evident that the fungus is *Phytophthora cactorum* (L. & C.) Schroet., as understood by Tucker and Leonian. *Phytophthora cactorum* is an omnivorous species having a wide host range, attacking species of *Malus, Pyrus, Juglans, Eriobotrya, Prunus,* and many others. This is the first time, however, that *Phytophthora cactorum* has been known to attack Pacific dogwood, *Cornus Nuttallii,* and madrona, *Arbutus Menziesii,* the two most important and widely used native ornamental trees in the Pacific Northwest.

PROOF OF PATHOGENICITY

The proof of pathogenicity in this study is based largely on the results of outside inoculations made on healthy, vigorously growing trees. Twenty carefully chosen trees of Pacific dogwood, *Cornus Nuttallii,* having a diameter range of approximately 3 to 14 inches, were selected for inoculation purposes. In a like manner, twenty trees of madrona, *Arbutus Menziesii,* ranging in diameter from 2 to 10 inches, were inoculated. In addition, a number of trees, representing both species, were selected as controls. Other species inoculated included Oregon maple, *Acer macrophyllum,* red alder, *Alnus rubra,* Scouler willow, *Salix scouleriana,* hazel, *Corylus californica,* and Douglas fir, *Pseudotsuga taxifolia.*

The outside inoculations were made on the stem, root crown, and roots. The two former were made in the following manner: the bark was surface-sterilized with 95 per cent ethyl alcohol and flamed briefly in the immediate area in which the inoculation was made. A boring was then made into the bark to the cambium with

a ⅝ inch cork borer. Dissecting needles were used to remove the bark disk. A bit of the mycelium, along with a small portion of the agar, was removed from the edge of a vigorously growing culture of *Phytophthora cactorum* and placed in the hole previously occupied by the disk. The disk was then returned to its original place, covering the inoculum. The wound was sealed with grafting wax to prevent excessive drying. All instruments were sterilized with 95 per cent ethyl alcohol and flamed with an alcohol lamp prior to their usage. Oatmeal agar served as the medium for cultures used in the experiment. Controls were carried out in a similar manner, in which sterile agar was substituted for the mycelium. The soil inoculations, however, were made in a slightly different manner. A portion of the soil surrounding the roots was removed, and an incision was made into the bark to the cambium with a sterile scalpel. A small portion of the mycelium was then placed on the fresh wound, after which the soil was replaced. Controls were made in the same fashion, with sterile agar replacing the inoculum. The depth at which the inoculations were made varied with the individual trees, but usually ranged between 3 and 6 inches below the surface of the soil.

Thirteen of the 16 stem inoculations on *Cornus Nuttallii* proved positive and produced cankers similar to those noted on naturally diseased trees (FIG. 5). There was no consistency in the size of the cankers resulting, indicating the possibility of differences in individual tree resistance or the presence of a number of different fungal strains. The average total vertical and lateral spread of the artificially induced cankers on *Cornus Nuttallii* for a period of 13 weeks, from the middle of April to the middle of July, was 7.2 inches and 3.9 inches, respectively. The largest canker had a spread of 20 inches vertically and 6.9 inches laterally. The smallest canker noted measured 2.4 inches vertically and 1.4 inches laterally. The 4 soil inoculations on *Cornus Nuttallii* failed. None of the controls was found positive. Fifteen of the 16 stem inoculations made on *Arbutus Menziesii* produced typical cankers 13 weeks after inoculation (FIG. 6). The average total vertical and lateral spreads measured 17.5 inches and 6.3 inches, respectively. The maximum individual vertical spread was 22 inches and the maximum lateral spread measured was 13.6 inches. Several of

FIG. 5. Artificially induced canker, 7 weeks old, on *Cornus Nuttallii*.

Fig. 6. Artificially induced canker, 11 weeks old, on *Arbutus Menziesii.*

the smaller trees were girdled. The minimum vertical and lateral spreads were found to be 12.2 inches and 2.4 inches, respectively. Two of the 4 soil inoculations proved positive. All of the controls were negative. The reason for the poor success with the soil inoculations on both hosts is probably due to a too rapid drying out of the soil rather than a physiological difference existing in the roots.

All of the other species of trees inoculated with *Phytophthora cactorum* were found more or less susceptible to infection. The pathogen proved quite virulent on *Acer macrophyllum*, and correspondingly less so on *Pseudotsuga taxifolia, Alnus rubra, Salix scouleriana,* and *Corylus californica,* in the order named.

From the inoculation tests it is indicated that the organism is somewhat more pathogenic to *Arbutus Menziesii* than it is to *Cornus Nuttallii.* Field observations of naturally diseased trees appear to bear out this fact.

In addition to the outside tests, inoculations made under laboratory conditions proved positive. Seedlings averaging 3 feet in height were found dead one month after inoculation at the root crown. Inoculations are apt to prove unsuccessful where the greenhouse temperature frequently exceeds 100° F.

When reisolations were made of the organism from the artificially induced cankers of both *Cornus Nuttallii* and *Arbutus Menziesii,* they were found to be identical with the original pathogen.

CONTROL

The extent of the artificially induced cankers was usually determined by cutting away the outer bark to reveal the discolored diseased tissues. Whenever the major part of the diseased area was so exposed, the further spread of the fungus seemed to be appreciably retarded. This observation suggested that scarification of the cankers might afford some measure of control, or at least check the progress of the canker. Accordingly, 6 of the actively spreading artificially induced cankers, 3 on madrona and 3 on dogwood, were treated in the following manner. A strip of healthy tissue approximately one and a half inches wide was removed all around the margin of the canker, exposing the cambium. All dis-

colored tissue, including sapwood, was carefully cut out. The diseased bark of the canker itself was then shaved away. One canker on each host was left without further treatment, but the other two were painted over immediately after scarification with Bordeaux paint (8, p. 29). Although not enough time has elapsed since this treatment to make any definite statement as to its ultimate success or failure, it can be said that in every instance the further spread of the canker was halted. The reader should consult the publication of Miller (4), and Baines (1), who found a similar treatment successful for loquat and apple trees. The lack of a broad invasion zone (see preceeding discussion) and the apparent susceptibility of the pathogen to heat and dryness should make scarification relatively simple, and may offer the hope of saving many valuable ornamental trees, or at least prolonging their life.

Other control measures are being investigated, but definite results have not been obtained.

SUMMARY

Increasing numbers of trees of Pacific dogwood, *Cornus Nuttallii* Aud. and madrona, *Arbutus Menziesii* Pursh., infected with a pathogen which causes serious cankers on the stems, ultimately girdling and killing the trees, are being found in and near Seattle.

The pathogen has been isolated repeatedly and obtained in pure culture from both *Cornus Nuttallii* and *Arbutus Menziesii,* and in all cases it has been identified as *Phytophthora cactorum* (L. & C.) Schroet.

Several trees of both madrona and dogwood were inoculated with pure cultures of *Phytophthora cactorum* obtained from stem cankers, and they subsequently developed cankers identical (in nature and appearance) with those associated with the disease as it occurs naturally. Several of the trees of both species inoculated in the same manner with sterile nutrient agar failed to develop any sign of a canker.

The fungus was reisolated from several of the artificially induced cankers, and found to be identical with the original isolants.

It is therefore concluded that *Phytophthora cactorum* (L. & C.) Schroet., is the cause of a serious stem-girdling canker of *Arbutus Menziesii* Pursh. and *Cornus Nuttallii* Aud.

Several of the artificially induced cankers have been scarified to determine the value of this procedure as a control measure. Although there has not yet been sufficient time to observe the final outcome, the scarification has thus far prevented the further spread of the cankers.

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LITERATURE CITED

1. **Baines, R. C.** *Phytophthora* trunk canker or collar rot of apple trees. Jour. Agr. Res. **59**: 159–184. 1939.
2. **Creager, D. B.** *Phytophthora* crown rot of dogwood. Jour. Arnold Arboret. **18**: 344–348.
3. **Leonian, L. H.** Identification of *Phytophthora* species. W. Va. Agr. Exp. Sta. Bull. 262, 36 pp. 1934.
4. **Miller, P. A.** *Phytophthora* crown rot of loquat. Phytopath. **32**: 404–409. 1942.
5. **Smith, C. O.** Inoculation of some economic plants with *Phytophthora cactorum* and *Phytophthora citrophthora*. Phytopath. **27**: 1106–1109. 1937.
6. **Tucker, C. M.** The taxonomy of the genus *Phytophthora* de Bary. Mo. Agr. Exp. Sta. Res. Bull. 153, 208 pp. 1931.
7. —— **& J. A. Milbrath.** Root rot of *Chamaecyparis* caused by a species of *Phytophthora*. Mycologia **34**: 94–103. 1942.
8. **Zeller, S. M.** Cankers of apple and pear in Oregon and their control. Ore. Agr. Coll. Exp. Sta. Circular 73, 29 pp. 1926.

UNILATERAL STIMULATION OF MICRO-
SPORUM AUDOUINI BY A NEW
SPECIES OF BACILLUS

T. BENEDEK [1]

(WITH 7 FIGURES)

During the comparative study of the genus *Microsporum* Conant (1) found that *M. Audouini,* in sharp distinction from *Microsporum lanosum,* does not vegetate at all on rice medium. He thus established a simple, useful and efficient method to differentiate human *Microsporum* from animal *Microsporum,* the differentiation of which due to their varying characters sometimes causes considerable difficulty in giant cultures.

A few years ago during study of a newly discovered species of *Microsporum, M. Stilliansi,* Benedek, 1938 (2) making comparative investigations with *M. Audouini* and several animal species of *Microsporum* on rice medium, I readily substantiated the observation of Conant as to the difference of viability of human and animal species of *Microsporum* on rice.

Rice medium [2] thus became one of the standard and most important mediums in' the study of the genus *Microsporum* in my

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[1] M.D. from the Laboratory for Mycological Research, Department of Dermatology, Chairman: Dr. Edward A. Oliver, Northwestern University Medical School, Chicago, Illinois.

[2] Conant (l.c.) prepared the rice medium in the proportion of one part of rice to three parts of water and placed in 125 cc. flasks. The medium was sterilized by exposure to free steam for an hour on two successive days.

I had to change this suggestion. In preparing the rice medium in the proportion 1:3 I found that the grains were not softened enough and after a short time the medium, sterile or inoculated, became stone-hard. Sterilized in free steam I always lost a number of flasks due to sporogenous bacilli. Finally in a large serial investigation 125 cc. flasks became so bulky that I had to reduce the size of the flasks to 50 cc. I changed the ratio rice—water 1:4 and sterilized 15 minutes at 20 pounds in the autoclave. The rice is softer and can be kept for several weeks without getting hard. Since autoclaving there was no loss of material. This method does not influence the goodness of the rice medium.

laboratory. The re-introduction of natural nutrient mediums may prove as revolutionary in mycological research as the introduction of solid (agar) mediums by Robert Koch proved to be in bacteriology.

As a rule every freshly isolated strain of *Microsporum* goes through rice medium in the process of identification [3] because that is at present the only sure way to exactly differentiate human and animal species of *Microsporum*.

During these routine examinations, a strain of *Microsporum Audouini*, No. 137, was freshly isolated from hair stumps of a negro boy, age 4. I observed that in the primary culture, about 14 days old, a bacterial growth conspicuous by its mustard-yellow color was vegetating along with the fungus. The young primary colony of this strain of *M. Audouini* grew so intimately intermingled with the yellow bacterial growth that a separation of the two microörganisms for the purpose of taking an inoculum for rice medium was practically impossible.

Thus the inoculum transplanted to rice was transmitted along with the yellow bacterial growth. I was fully aware of this fact, but I did not lay any importance upon it, knowing that many bacterial growths do not interfere with the vegetation of hyphomycetes because the latter over-and-outgrow the bacteria.

About five days later on inspecting the rice medium inoculated with strain No. 137, I observed against any expectation and strictly contrary to the experience of Conant and myself—that this strain of *M. Audouini* had begun to grow and later on yielded a luxuriant growth on rice medium.

It was observed that the growth of *M. Audouini* No. 137 on rice was the quickest and most intensive in areas where the mustard-yellow bacterial growth was the most luxuriant. Microscopic examination of the fungal growth revealed (1) the mustard-yellow bacterial growth vegetating along the mycelia, (2) the *M. Audouini* producing many giant septate and non-septate spindle spores, contrary to its attitude on any of Sabouraud's or similar nutrient mediums, where macroconidia usually are sparse or completely missing.

[3] For primary culture I usually use Difco Sabouraud glucose agar, pH 5.6.

Knowing that the strain No. 137 was positively a human strain, *M. Audouini,* and that no *M. Audouini* grows on rice medium, on one hand, and observing the best growth of this strain on rice on the spots with the most luxuriant growth of the bacterial colony, it was quite natural to assume that the presence and only the presence of this mustard-yellow bacterial growth stimulated the *M. Audouini* strain No. 137 to grow on rice.

After many months of painstaking work, two important goals were reached. One was the successful separation of strain No. 137 of *M. Audouini* in pure culture without any concomitant bacterial growth. The second one was the isolation of this mustard-yellow bacterial growth in pure culture. This was more difficult because it was intermingled with *B. subtilis, Staphylococcus albus, Staphylococcus aureus,* and a few more but unidentified cocci and bacterial rods.

Further investigation showed that this vital stimulation is a permanent effect to be elicited at any time and with any strain of *M. Audouini.* It had to be proved that in the primary vegetation of the mustard-yellow bacterial growth (along with shorter and longer, gram-positive and gram-negative, sporogenous and non-sporogenous bacilli and various cocci) only the mustard-yellow pigment producing microörganism was responsible for this unilateral, vital stimulation.

As to the purified, primarily contaminated strain No. 137 of *M. Audouini,* it was easy to prove that this strain did not yield any growth on pure rice medium.

I

To check whether *M. Audouini* does or does not grow on rice in pure strains, ten freshly isolated strains of this fungus were inoculated on rice medium. As usual, the inoculum was a lentil-sized particle of the leathery growth separated as far as possible from the agar nutrient medium and deposited on three different, isolated spots on the rice surface.

Within four weeks, at room temperature (22°–23° C.), ·no growth took place.

It was conclusively proven that growth of pure strains of *M. Audouini* on rice medium does not take place.

II

Concerning the peculiar stimulating symbiotic effect, two further experiments were carried out.

(a) The contaminated strain No. 137 of *M. Audouini* was inoculated again on rice medium, and left at room temperature, to duplicate the first basic observation.

Within three weeks the whole surface of the rice medium was covered with a dense grayish-white fuzzy growth.

(b) To ascertain whether this phenomenon occurs only with the contaminated strain No. 137 or other pure strains of this fungus contaminated afterwards with a pure culture of *B. weidmaniensis,* act in the same way pure strains of *M. Audouini* were transferred in the way described above, along with *B. weidmaniensis,* on rice medium.

Within five days the fungus grew well all around the inoculum.

Conclusively the vital stimulation was not an incident, but a constant phenomenon elicitable any time, with any strains of *M. Audouini* contaminated by *B. weidmaniensis.*

III

In this experiment ten freshly isolated pure strains of *M. Audouini* were used. Lentil size inoculums without adhering agar were implanted on three different points on the surface of the rice medium.

These rice cultures were left for eleven days at room temperature. No growth whatsoever took place. The inoculums on the contrary, turned dark brown, they were almost dried up.

On the 12th day the rice grains around the inoculums were infected from a pure culture of *B. weidmaniensis,* three days old, grown on Difco Sabouraud glucose agar, at room temperature.

After 8 to 10 days a vivid growth of *M. Audouini* resulted in each flask around one or two or all three inoculums.

This was a further proof that *B. weidmaniensis,* induces the growth of *M. Audouini* on rice medium.

IV

I prepared rice medium in the usual way and infected it with the pure strain of *B. weidmaniensis,* on three different and distant

points on the surface. After an incubation of 24 hours at 23° C., vegetation of *B. weidmaniensis,* on the rice medium was well visible.

From ten strains of *M. Audouini* in second and third subcultures inoculums were taken and one or two rice flasks were inoculated as usual on all three points showing the presence of the yellow bacterial growth. After six days all the points of inoculation showed growth and after six weeks the whole surface of the rice medium was covered with fungus growth.

In this experiment double controls were used. *B. weidmaniensis,* on rice alone showed luxuriant growth at room temperature. From all the pure strains of *M. Audouini* used in this experiment, pure rice mediums were inoculated. The latter ones remained without any sign of growth at the end of six weeks at room temperature.

As a further control, *M. felineum* and *M. lanosum* were used. Anytime, whenever repeated, these fungi showed a prompt and luxuriant growth on pure rice medium from the 3rd to 5th day.

B

The unilateral vital stimulation of *B. weidmaniensis,* on *Microsporum Audouini* induced not only a vegetation on rice medium with rich production of large septate and non-septate spindle spores, which are extremely rare or not present at all on Difco Sabouraud glucose agar, but it caused this imperfect fungus to

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Figs. 1–7. *B. weidmaniensis.* 1, grown on Difco Sabouraud glucose agar, 7 days old, at 22° C., stain: methylene blue, microörganisms unstained; 2, grown on Difco Sabouraud glucose agar, 7 days old, at 22° C., stain: methylene blue, microörganisms unstained, rods are here more slender; 3, grown in dextrose broth, pH 6, 7 days old, at 22° C., stain: methylene blue, microörganisms evenly stained; 4, grown on carrot, 7 days old, at 22° C., stain: methylene blue, microörganisms unstained; 5, grown on rice medium, 7 days old, at 22° C., stain: methylene blue, microörganisms mostly evenly stained; 6, grown on carrot, six weeks old, at 22° C., stain: Ziehl-Neelsen spore staining, details in the text, with enlarging glass tiny dots—the spores —are visible at any point of the preparation; 7, grown on blood agar slant, 7 days old, at 22° C., stain: methylene blue, staining is fairly even, microörganisms reveal great polymorphism. All the figures are photomicrograms, taken with Zeiss Phoku, objective: fluorite oil immersion loop, homal 6.2 ×.
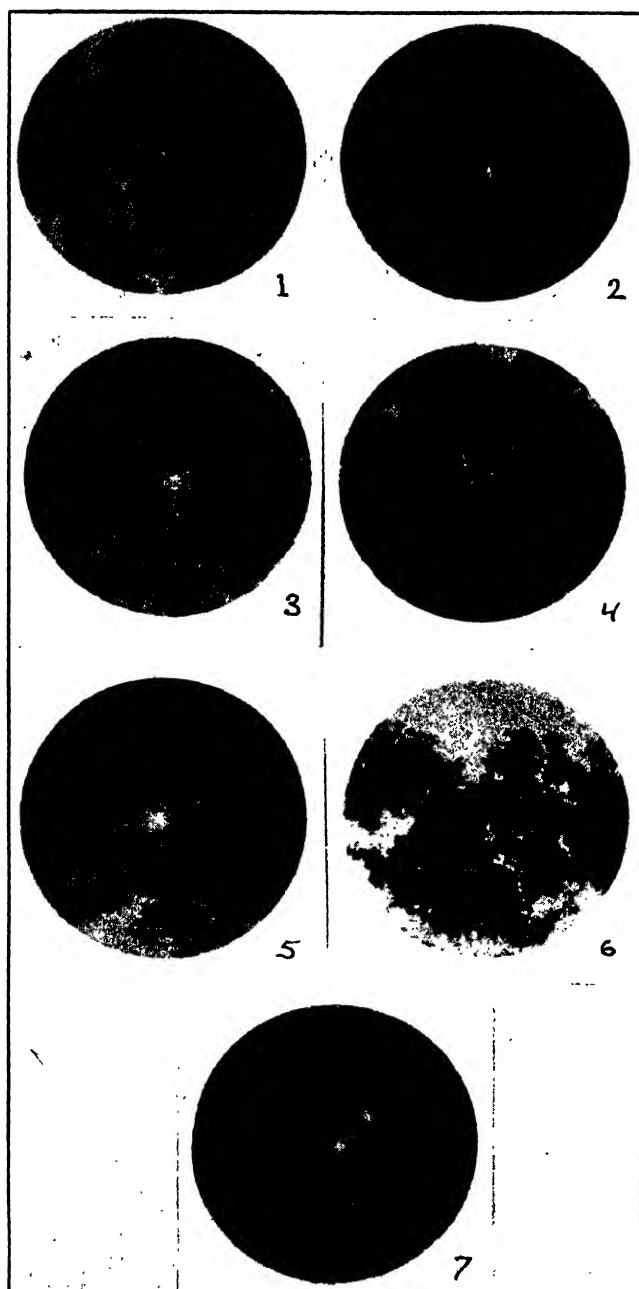
FIGS. 1–7.

produce in extreme abundance perfect perithecia. *B. weidmanien-sis* was thus the first agent by means of which a medically so important hyphomycete such as the *Microsporum Audouini* could be forced to produce perithecia. The old assumption of Matruchot and Dassonville (3), Eidam (4), and others that the medically important hyphomycetes are the imperfect forms of Ascomycetes, has thus been proved true, at least for the Microsporum group.[4]

Mycologists may be interested in this peculiar bacterium. It is extremely easy to handle, not having any kind of special or difficult cultural requirements. It need not be transferred oftener than any hyphomycete. The same routine mediums can be used for transfer as generally used in mycology.

Furthermore this bacillus may prove to be of great heuristic value as a biological tool in investigation and in the attempt to induce higher form of fructification in different species of fungi imperfecti.

This discovery may arouse interest in a systematic investigation of the value of different bacteria as unilateral vital stimulating agents in connection with hyphomycetes for the production of higher form of fructification.

The discovery raises more biological questions than can be answered at the present moment. What is the mysterious principle produced by *B. weidmaniensis,* which induces the formation of perithecia? Is this unilateral vital stimulation bound to the living microörganism or can some chemical principles be isolated from its culture causing the same effect? Are there certain cytological differences in the structure of certain mycelia, proper only to a restricted number of mycelia in any thallus still carrying genes of a past and almost forgotten ascomycetic stage? Is any part of a thallus without possible cytological differentiation apt to be stimulated backwards into the ancient primary ascomycetic stage? These are only a few of the questions that arise.

The results already achieved and the problems to be investigated justify the systematic description of this new species of *Bacillus.*

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[4] Details on perithecium formation in the genus *Microsporum* are forthcoming in a subsequent publication.

Bacillus weidmaniensis, sp. nov.[5]

I. *Microscopic appearances:* short rods, with rounded ends, $1.5 \mu \times 2.0 \mu$–3.0μ. Protoplasmic contents homogenous, highly refractile. There is no special grouping. Staining reaction: there is no capsule. Simple dye solutions (methylene blue, carbolfuchsin) give slight or no staining at all, depending on the cultural medium. Using 20 per cent tannin solution as mordant methylene blue as counterstain is taken by some, but many individuals are slightly stained or they remain unstained. The bacillus is gram-negative, non-motile and sporogenous.

II. *Growth characteristics:* The growth is quick and luxuriant on all mediums tested. Optimal temperature is 22°–23° C. (room temperature); 37° C. is inhibitory to growth, but when after 48 hours at 37° C. it is put at room temperature again, it slowly recovers and gives a luxuriant culture. Ice box temperature inhibits the growth, too. Fresh inoculums kept at 5° C. for two weeks did not show any growth. But when taken to room temperature, the same tubes yielded luxuriant growth in 48 hours. Aerob, facultative, it produces a mustard-yellow pigment on all synthetic and natural culture mediums.

A. GROWTH ON GELATINE

Stab culture: in plain gelatine only surface growth, no growth in stab, no gas formation. In dextrose and lactose gelatine beside luxuriant surface growth scanty growth in the stab canal with fine gas bubbles in lactose gelatine. The rate of growth is quick on the surface, yielding in 48 hours a 5 mm. glistening plaque with a convex granular center and a flat, smooth, sharply defined periphery. There is no liquefaction within 14 days. Color is mustard-yellow. No odor produced.

B. GROWTH ON AGAR AT 22°–23° C.

(1) Stab: in peptone agar, Difco Sabouraud glucose agar, lactose and glycerin agar there is quick growth on the surface, pin-

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[5] *B. weidmaniensis* is deposited under the accession number *8239* at the American Type Culture Collection, Georgetown University Medical School, 3900 Reservoir Road, N.W., Washington, D. C.

point size colonies, very scanty at the upper part of the stab canal; no growth in the deeper part of the canal.   No gas formation.

(2) Streak: on pepton agar, Difco Sabouraud glucose agar, glycerin, lactose and beer wort agar, the growth is quick, luxuriant, glistening, the streak is a broad band, sharply defined.

(3) Plate culture: shake cultures yield on pepton agar and Difco Sabouraud glucose agar flat convex, sharply defined, smooth, glistening colonies with ground glass transparency.   Deep colonies are of pinpoint size.   On beer wort agar superficial colonies are droplet-like, entire, sharply limited, homogenous.   Deep colonies are pinpoint to pinhead size.

C. GROWTH IN BOUILLON

In dextrose broth there is thick scum formation of a mustard-yellow color within 24 hours at 22°–23° C.   Disturbed the scum sinks to the bottom and forms again.   The medium remains clear. there is no odor, the original reaction of the medium (pH 7.2) is not changed within eight days.

In plain nutrient broth the characteristics of the growth depend on the pH of the medium.

At pH 4.5 there is no growth in the first 24 hours.   After three days, however, there is slight turbidity, a perfect thin scum and ring formation.

At pH 5.0 and pH 6 0 slight turbidity within the first 24 hours. Slight veil but no ring formation.   Crumb-like bottom growth.

At pH 7.0 the turbidity is dense within 24 hours.   There is ring formation, fine veil formation and sediment.

At pH 8.0 turbidity is slight again as it was at pH 6.0 with fine mustard-yellow veil formation, ring formation and slight sediment.

After three days plain nutrient broth is entirely clear again.

In unhopped beer wort (unadjusted, pH 5.5), there is slight turbidity within 24 hours, sediment, thin, granular veil formation, no gas formation.   After three days absolute turbidity, thick scum formation.

D. GROWTH IN SPECIAL MEDIUMS

On blood agar the streak becomes broad with sharply defined edges, granular surface.   Color is at first mustard-yellow, later

turning greenish-yellow. The growth is similar to that on Löffler's serum agar. On potato growth is luxuriant with confluent granular glistening surface. On carrot the millet-size colonies are luxuriant, spreading, glistening. Milk remains unchanged. On rice medium there is a slow growing, thin, glistening mustard-yellow layer. Litmus milk shows slow discoloration, original pH 6.9 changes to pH 6.55 (electrometric) in 13 days. Indol is not formed. Nitrates are not reduced.   .

E. THERMAL DEATH POINT

It was determined in unhopped wort (unadjusted) pH 5.5. The culture used was one in Difco Sabouraud glucose agar, 48 hours old.

It was found that 85° C. (water bath) in 10 minutes kills the bacillus. Subsequent inoculum on Difco Sabouraud glucose agar yielded no growth.

F. VIABILITY ON ARTIFICIAL MEDIUMS

This microörganism has a remarkable viability on all the mediums tested, liquid or solid. Except for total dryness inoculum gives positive transfers after 3 months and more.

III. MICROSCOPICAL MORPHOLOGY OF THE MICROÖRGANISM ON DIFFERENT LIQUID AND SOLID MEDIUMS AT VARIOUS pH

The most conspicuous microscopical characteristics of this microörganism is its polymorphy depending mainly on the pH of the medium. The second conspicuous feature is the staining property with anilin dyes which is most conspicuous with Löffler's watery methylene blue. It does not take dye at all, giving a negative picture of the microörganisms or if slightly taken, there remains usually in the center of the rod an unstained spot, a well known picture in sporogenous rods.

Because of the confusing polymorphy of this microörganism I found it the best in order to recognize it with certainty and to determine the purity of its culture to use as standard medium Difco Sabouraud glucose agar, pH 5.6. The bacillus yields on

this medium fairly large rods with rounded ends, almost uniform, not staining at all with methylene blue.

This procedure was used to recognize the organism and the purity of its culture from the different liquid and solid mediums. Despite the confusing polymorphy on some of the mediums a retroculture on Difco Sabouraud glucose agar gave always the uniform picture of the microörganism, characteristic for this medium.

A. MORPHOLOGICAL CHANGES OF B. WEIDMANIENSIS IN CONNECTION WITH THE VARIABILITY OF pH IN PLAIN NUTRIENT BROTH

This investigation was carried out in 24 hour old broth cultures at 22°–23° C. (room temperature) with Löffler's watery methylene blue.

pH 4.5. Shorter or longer, thin rods, coccoid or diplococcoid forms. Rarely giant rods or sausage shape individuals. No filaments. Unevenly stained.

pH 5.0. Size, shape, staining property of individuals taken from the scum show the greatest polymorphy.

First there are the always recurring small short thin rods taking methylene blue well and evenly. They are single, in. pairs or forming longer chains of 6–12 individuals.

The second most conspicuous individuals are represented by globoid, ovoid or lemon-shape bodies $1.5 \times 1.5 \mu$ to $2 \times 2.0 \mu$ showing only a faintly stained contour, the protoplasm remaining entirely unstained. They are single, in pairs or forming short chains of three or more individuals. Many are completely unstained; others, however, show at the periphery, apparently between the outer membrane and the protoplasm, one or two, dot-like, rod-like, or crescent-shape, metachromatically (red) stained corpuscles, sitting equatorially or at the poles. Some show blue or metachromatic bodies, several in number, in a clear unstained protoplasm.

Other peculiar forms are the large thick rods, $3–4.5 \mu \times 1.5 \mu$. Many are short, plump, others longer and thick. Straight or slightly (semilunar) curved. Some are sausage-shape or like a

triangle. They are more or less evenly stained blue; but they either show one or more round spots in the body much brighter stained than the rest or there are two or more metachromatic (red) bodies along an axis within the blue area of the protoplasm.

Further, there are thin, long filaments 12.0 $\mu \times$ 1.5 μ, 20–24.0 μ $\times$ 1.0–1.5 μ revealing more or less conspicuous swelling at one or both ends, or at one or several spots along the thread. They are usually well and evenly stained. Sometimes, however, they show one or more round unstained spots, or only brighter stained spots like a spore.

pH 6.0. The polymorphism is almost entirely stopped. The population of the veil consists almost completely of the usual "normal" short, thin rods, single, in pairs, or in short chains. They are well and evenly stained. Very rare are the unstained globoid or ovoid forms as described at pH 5.0. Infrequently, many large rods and bigger filaments can be found, swollen at one end like a sausage, button-like at the other one or shaped like a spermatozoon.

pH 7.0. The population consists in almost uniformly short thin rods, single or in pairs, or coccoid or diplococcoid forms, partly evenly stained, partly revealing a central unstained spot.

pH 8. Mixed picture: Foremost the coccoid, diplococcoid forms, to a lesser extent thin and short-rods. Staining is poor.

Beer wort 5.5 pH (unadjusted). Short rods (.3 $\mu \times$ 1.5 μ) single or in chain, coccoid or diplococcoid forms. Staining is poor.

B. MORPHOLOGICAL PICTURE OF B. WEIDMANIENSIS ON AGAR, GELATINE, CARROT AND POTATO

This investigation was carried out in 48 hours old cultures, grown at 22°–23° C., pH of the mediums is not adjusted. Each medium has the routinely used pH. Stain: Löffler's watery methylene blue.

(a) Characteristics on agar mediums

(1) Löffler's serum agar: reveals an extreme polymorphism represented by tiny coccoid forms (0.3 μ), large ovoid bodies and short rods (.3 $\times$ 1.0 μ). Most conspicuous is the staining reac-

tion.   Some individuals are entirely stained.   Others are very pale
blue, while many are not stained at all, showing only a thin pale
blue contour.   In such individuals there is usually a blue-black
dot in the center.   Many individuals are stained red (metachro-
masia).

(2) Blood agar slant: shows similarly a great polymorphism.
Tiny coccoid and diplococcoid forms, short thin rods make up the
population.   Staining: many individuals take the stain very poorly,
some are normally stained, but they are always uniformly stained.
Size: $2.0\,\mu \times 0.3\,\mu$.

(3) Beer wort agar slant: reveals extremely small coccoid forms
and thin short rods, usually deeply stained.   The prevalent forms
are thick, shorter and longer rods or ovoid forms, entirely un-
stained, thus giving only a negative picture of the rods, $1.5\mu \times 3.0\,\mu$
in size.   Many show, however, a very pale blue stained tiny dot.

(4) Beer wort agar plate: shows short rods, single or in pairs,
or in short chains; individuals with rounded ends, straight rods;
exceptionally longer threads.   Mostly they are evenly stained,
many reveal, however, a brighter stained spot in the center.   Size:
$1.0\mu \times 4.5\,\mu$, $1.0\mu \times 3.0\,\mu$.

(5) Pepton agar slant: population is extremely polymorphous:
there are tiny coccoid forms, short rods, plump larger, rods, thin
filaments $6.0\,\mu$–$10.0\,\mu \times 0.3\,\mu$.   Many individuals are well stained,
some are very pale blue.

(6) Pepton agar stab: shows very short rods, but mainly globoid
and ovoid bodies, mostly not taking the stain.   They usually show,
however, one or two tiny point-like bodies in the unstained proto-
plasm.

(7) Difco Sabouraud glucose agar: on this medium one has the
most typical picture of this microörganism as to its size, shape and
its peculiar relation to aniline dyes.   The shape and size of the
bacillus is almost uniform consisting in short plump rods with
rounded ends, not taking methylene blue at all.   One has after
staining only a negative picture of the contours.   Size: $1.5\,\mu \times$
2.0–$3.0\,\mu$.

(8) Glycerin agar streak: reveals almost entirely uniform glo-
boid or slightly ovoid forms; rods are exceptional.   Staining leaves

almost uniformly an unstained spot in each individual. Size: 0.5 μ × 0.75 μ.

(9) Pepton gelatine stab: great polymorphism is present: tiny coccoid forms, short thin rods making up the bulk of the population, few large plump rods, sausage-like pairs. Size: 0.3 × 0.3 μ; 0.5 × 0.5 μ; 1.0 × 4.5 μ; 2.0 × 0.5 μ; 1.5 × 1.5 μ. They are stained evenly.

(10) Dextrose gelatine stab: population consists of uniform short rods, almost no coccoid forms or larger individuals. Staining is even. Size: 0.5 μ × 2.0 μ.

(11) Lactose gelatine stab: morphology of the population is identical with that on dextrose gelatine stab.

(12) Plain nutrient broth, pH 7.2; the rods are extremely short, reduced almost to ovoid or larger coccoid or diplococcoid forms. There are oftener forms resembling a thick sausage or 2–3 in a row hanging together by a thin thread like a wreath of sausages. Many are evenly stained, particularly the coccoid forms. The rods, especially the longer rods show brighter stained round spots in the center or nearby or they are absolutely unstained. There is no thread-formation. One observes, however, chain-formation consisting of 6–12 individuals. Coccoid forms measure: 1.0 μ × 1.0 μ; 1.5 μ × 1.5 μ; rods: 1.5 μ × 4.5 μ, 1.0 μ × 2.0 μ.

(13) Dextrose broth: morphology of the bacillus is identical with that on plain nutrient broth.

(14) Carrot: the morphology is very impressive. There are short plump rods, globoid or ovoid small bodies not taking the stain at all. In individuals grown on carrot the tiny, deeply stained, point-like body somewhere within the entirely unstained protoplasm is most conspicuous. Size: 1.0 μ × 1.5 μ; 0.3 μ × 0.3 μ; 0.5 μ × 0.5 μ.

(15) Potato: the morphology is entirely different from that on carrot. There are evenly stained short thin rods or ovoid bodies. Many are deeply, others brighter stained. Growth shows a great uniformity in shape and size: 0.3μ × 1.5 μ; 0.5 μ × 0.5 μ.

(16) Rice medium: reveals short to very short rods or coccoid forms. There are plenty of sausage-shape individuals, large ovoid forms, chains of large ovoid forms. The short rods and coccoid forms are mostly evenly stained; the large forms take the stain

badly, they show only a pale hue of the stain, oftener they reveal an unstained spot somewhere in the center. Size: $0.3\,\mu \times 0.3\,\mu$; $0.5\,\mu \times 0.5\,\mu$; $1.0\,\mu \times 0.3\,\mu$; $2–3\,\mu \times 2–3\,\mu$.

Taxonomic position of B. weidmaniensis

The newly discovered microörganism is characterized by rod-shaped cells, production of a mustard-yellow pigment on all mediums—liquid or solid—by extreme polymorphism and definite spore-formation. It is non-motile, aerobic, gram-negative and it does not liquefy gelatine.

The endospore-formation puts this microörganism into the Family V. Bacillaceae Fischer, 1895 and being aerob into Genus I. *Bacillus*.

It is, however, somewhat difficult to demonstrate the spores, because they are extremely small and on certain mediums they show up very lately, if at all. In a six weeks old culture on potato with luxuriant growth one can hardly find spores. For demonstration of endospores an older culture (six weeks and older) of *B. weidmaniensis* on Difco Sabouraud glucose agar is the best.[6]

It could not be identified with anyone of the aerobic, facultative, mesophilic non-motile Bacilli listed in Bergey's Manual.[7,8]

[6] Spore staining used: mordant: 20 per cent sol. acid. tannic; stain: Ziehl-Neelsen carbolfuchsin; decolorant: 5 per cent sol. acid. sulphuric; counterstain: methylene blue.

[7] Bergey's Manual of Determinative Bacteriology, 5th Edition, 1939, Baillière, Tindall, & Cox, London.

[8] Due to its extreme polymorphism the new species had to be compared most closely with only one species, *Flavobacterium proteus,* Shimwell and Grimes. (J. L. Shimwell, A study of the common rod bacteria of Brewer's yeast. J. Inst. Brewing, 42 (N.S. 33): 119–127, 1936.)

	Flavobacterium proteus	B. weidmaniensis
Broth	Turbid in 24 hours at 30° C. with a slight surface scum.	Turbid in 24 hours at 22° C. with thick surface scum and ring formation; medium clear after three days.
Litmus Milk	Unchanged.	Changed.
Potato	A slight, barely visible growth consisting of a narrow filiform dirty yellow line.	Luxuriant growth with intense mustard-yellow color.
Nitrates	Reduced.	Not reduced.

The difference among the two microörganisms are conspicuous.

This new species, on account of its outstanding biological effect on Fungi, is dedicated in honor to the prominent American medical mycologist, Fred. D. Weidman.

COMMENTS

According to *De Bary's* definition, symbiosis is the phenomenon of an intimate and constant association of two generally different microörganisms in conditions which may be considered as mutually beneficial for both.

Van Tieghem (Traité de Botanique, 1891) defined symbiosis as a formation of a single physiologic unit by means of two morphological units. This definition includes the intimate and constant association of two symbiotic organisms without being concerned with the benefit which each one may or may not derive of this association.

With *Papacostas and Gaté* (5), we call the phenomenon of symbiosis "stimulative" if two microörganisms cultivated on the same medium *in vitro* reveal a favorable effect as a result of this association. This stimulating effect may be mutual: reciprocal stimulation; or if it effects favorable only one of them: unilateral stimulation. On the other hand, it can effect the development, the vegetation of one of these microörganisms: vital stimulation, or it effects only a microbic function (*e.g.* toxin production, pigment production): functional stimulation.

A. Vital symbiosis

In the present discussion the symbiosis of *Microsporum Audouini* with *B. weidmaniensis,* n. sp., is a unilateral vital stimulation, very similar to the effect of Rhizoctone on Orchid seeds.

Wort	Grows with a pronounced parsnip-like odor.	No odor produced of any kind, on any mediums.
Thermal Death Point	54° C. for five minutes.	85° C. for ten minutes.
Spore-formation	Absent.	Present.
Habitat	Brewer's yeasts.	Scalp of a negro boy.

Noël Bernard's (1904) (6) investigations are classical on the germination of the orchids. The seeds of this plant are infected by a fungus (Rhizoctone). In this association the fungus finds its proper nutrient medium on the seed, while, on the other hand, the germination of the seeds to be impossible without the presence of this fungus.[9]

Another example of this phenomenon is revealed by the root nodules of leguminous plants (pea, bean). These nodules are formed by the parenchyma of the root hypertrophied due to the presence of a given species of Nitrobacteriaceae. The benefit is mutual. The bacterium uses the carbohydrates of the vegetable, giving the latter atmospheric nitrogen bound by it.

Papacostas and Gaté summed up in their monograph the scattered data on vital and functional stimulation found in fungi up to 1928. The material is very meager bearing mainly on the symbiosis between yeast and yeast, yeast and bacteria, bacteria and a few species of the family Aspergillaceae.

In the older literature on the subject, I found two important observations not mentioned in the monograph of *Papacostas and Gaté:* the observations of *Molliard* and of *Sartory* having direct connection with my observation on vital symbiosis.

Molliard (1903) (7) isolated the *Ascobolus furfuraceus* from cowdung. Starting from ascospores of this fungus in an aseptic way, he got an intense development of mycelium on carrot, for instance, yielding a large number of arthrospores. This fuzzy white mycelium produced perithecia seldom, and when it did they were incomplete and appeared only after 4–6 weeks.

A few cultures, however, had a different aspect. The mycelium formed a veil adhering to the nutrient media, carrot being used.

[9] The existence of a mutually beneficial symbiosis between orchids and certain filamentous fungi was advanced by N. Bernard in 1904 and subsequently supported by Burgeff (1909, 1911, 1936), Costantin (1917) and Ramsbottom (1922, 1927). Lately J. T. Curtis (1939) offered evidence that the orchid-fungus relation is non-specific. He believes that the symbiotic relationship is one of parasite and host, with the orchid deriving no benefits from the fungus in its roots. (Cf. J. T. Curtis: The relationship of specificity of orchid mycorrhizal fungi to the problem of symbiosis. Am. Jour. Bot. **26**: 390–399, 1939; Knudson: Bot. Gaz. **73**: 1–25, 1922 and ibidem, **89**: 192–199, 1930.)

These cultures produced perithecia within 10–15 days in abundance. On microscopic examination it was seen that there was a "bacterium" (not named) vegetating along with the mycelium.

Afterwards he isolated this "Bacterium" and the fungus in pure culture. When sterilized cow-dung was first infected with the bacterium and inoculated afterwards with the fungus (*Ascobolus furfuraceus*), this culture always yielded abundant perithecia.

No explanation is attempted of the dynamics of this phenomenon.

Molliard's observation (1903) is, I believe, the first one concerned with production of perithecia in Ascomycetes as a result of interference of a Bacterium in a unilateral vital stimulation. It is well known, that saprophytic ascomycetes in pure culture seldom produce on any medium anything but sterile mycelium or conidial fructification, almost never perithecia.

A. Sartory (1916) (8) isolated an *Aspergillus* from humid straw and feather of a crow, nearly identical with *Aspergillus B.* var. *Scheelei* Bainier Sartory.

Transplanting conidia and mycelium (contaminated culture) to sterilized wet straw he got the form *Eurotium* (ascogenous form of *Aspergillus*) at the end of about ten days. The number of perithecia was large, golden-yellow in color, variable in size, the largest ones being between 90μ and 100μ in diameter. The perithecium was cleistocarp, the asci carrying eight ascospores, $4.5 \mu \times 5.5\mu$, oval, from profile with a furrow.

After having isolated this *Aspergillus* in pure culture, the perithecium formation ceased entirely and it could not be elicited on any kind of synthetic or natural (leather, straw, carrot, potato, etc.), mediums. This author remembered, however, of having isolated along with the *Aspergillus* a bacterium from the group of *B. mesentericus*.

Having inoculated this bacterium with the *Aspergillus* he permanently got the form Eurotium provided the bacterium did not reach an extensive vegetation. Optimal temperature was at $+ 22°$ C.[10]

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[10] I tried to duplicate this experiment of Sartory using *Aspergillus flavus* and *B. mesentericus* on rice medium. I failed. I succeeded, however, in producing perithecia in *Aspergillus flavus* by means of *B. weidmaniensis* on rice medium.

Sartory assumed with *Pinoy* that the *B. mesentericus* only "modifies" the nutrient media for the *Aspergillus* without any other kind of biological interference. In my opinion this biological phenomenon is far more complicated than that.

B. Vital antibiosis

Antibiosis, a term introduced for the first time by *Vuillemin,* in 1889, was also observed in fungi. Some experiments were carried out mainly on yeasts and bacteria, to a lesser extent between bacteria and hyphomycetes and here again mainly in the family Aspergillaceae.

When the association of two microörganisms in vitro have an inhibitory effect, we call it, with *Papacostas and Gaté,* antibiosis. This may be mutual or unilateral. If this condition effects the development, the vegetation of one of them: vital antibiosis; if some function is inhibited or disturbed (*e.g.* pigment or toxin production) : functional antibiosis.

During the investigation on vital stimulation between *M. Audouini* and *B. weidmaniensis,* I observed instances of definite antibiosis between *M. Audouini* and several bacterial species originally present in the mixture of bacterial growth. *B. subtilis, Staphylococcus aureus* and *Staphylococcus albus* had a unilateral vital antibiotic effect on *M. Audouini,* absolutely impeding the growth of any pure strain of *M. Audouini* even on glucose agar medium.

The phenomenon of symbiosis and antibiosis among microorganisms finds more and more interest among mycologists and bacteriologists.

Chambers and Weidman (9) found interesting instances of vital antibiosis. In their experiments *Bacillus subtilis* entirely inhibited *Trichophyton interdigitale* in thirty-four of forty tests and restrained it in the remainder. The same vital antibiosis was found if they used *Bacillus subtilis* in association with *Trichophyton purpureum, T. gypseum, T. asteroides, T. pedis, T. acuminatum, T. lacticolor, Microsporum lanosum, M. Audouini; T. violaceum, Sporotrichum schenkii.* All ten species were completely inhibited and have remained so up to the drying point of the substrate. Blood agar was used as nutrient medium throughout these experiments.

P. A. Ark and Marjorie L. Hunt (10) recently called attention to the phenomenon of bacterial antibiosis. They isolated a number of bacterial species which were antagonistic to phytopathogenic microörganisms in varying degrees. Special attention was given to two soil bacteria which showed a strong antagonism both to bacteria (gram-positive and gram-negative) and to certain fungi.

SUMMARY

Conant's observation that *Microsporum Audouini* does not grow on rice medium in contradistinction with any other known species of the genus *Microsporum* was fully confirmed.

The incidental observation of the presence of a yellow pigment producing microörganism in the primary culture of a strain of *Microsporum Audouini* led to the discovery of *B. weidmaniensis,* and to the evidence of the phenomenon of a unilateral vital stimulation between these two microörganisms.

In the presence of *B. weidmaniensis, Microsporum Audouini* does grow on rice medium and in certain instances it does even produce perfect perithecia.

The mustard-yellow pigment producing, spore-bearing bacillus, *B. weidmaniensis,* is distinct morphologically and physiologically from all the known species of the Genus *Bacillus.* Its full description is given.

B. weidmaniensis is the first representant of the Genus with the distinct property of unilateral vital stimulation on Fungi.

LITERATURE CITED

1. **Conant, N. F.** Studies in the genus *Microsporum*. 1. Cultural studies. Arch. Dermat. & Syph. **33**: 665–683. 1936.
2. **Benedek, T.** On a new species of the genus *Microsporum, Microsporum Stilliansi,* Benedek, 1937, n. sp., with special consideration of the phenomenon of dissociation in fungi imperfecti. Jour. Trop. Med. & Hyg. April 1, 1938.
3. **Matruchot, L. & Dassonville, C.** Sur le Champignon de l'herpès (Trichophyton) et les formes voisines et sur la classification des Ascomycètes. Bull. Soc. Myc. France **15**: 240.
4. **Eidam, Ed.** Zur Kenntnis der Entwicklung bei den Ascomyceten. Cohn's Beiträge zur Biologie der Pflanzen **3**: 377–433. 1879–1883.
5. **Papacostas, G. & Gaté, J.** Les associations microbiennes, Gaston Doin & Co. Paris, 1927.

6. **Bernard, Noël.** Recherches experimentales sur les Orchidées. Rev. Gén. Bot. **16**: 405–451, 458–476. 1904.
7. **Molliard, M.** Rôle des bactéries dans la production des périthèces des *Ascobolus*. C. R. Acad. Sci. Paris **136**: 899–901. 1903.
8. **Sartory, A.** De l'influence d'une bactérie sur la production des perithèces chez un *Aspergillus*. C. R. Soc. Biolog. **79**: 174–175. 1916.
9. **Chambers, St. O. & Weidman, Fred.** A fungistatic strain of *B. subtilis* isolated from normal toes. Arch. Dermat. & Syph. **18**: 568–572. 1928.
10. **Ark, P. A. & Hunt, Marjorie L.** Saprophytes antagonistic to phytopathogenic and other microörganisms. Science **93**: 354–355. 1941.

MYCOLOGICAL NOTES FOR 1939–40 [1]

L. O. OVERHOLTS

(WITH 7 FIGURES)

This paper is a continuation of a series with similar title begun in 1919 and continued until the present time. They represent an attempt to call attention to the new and unusual fungi encountered from year to year, especially those inadequately known or lacking complete descriptions and illustrations.

I. PHYCOMYCETES

SYNCHYTRIUM AUREUM Schroet.

This species of the order Chytridiales is known on many hosts; the addition of another is hardly to be classed as astounding. However in June, 1940, while collecting near St. Marys, Elk Co., Pa., several plants of *Trientalis americana* were discovered which appeared to be infested by a fungus of the *Synchytrium* type. Perusal of the literature showed no such host for any member of the Chytridiales. Specimens submitted to W. W. Diehl were named as belonging here. The fruiting of the fungus did not affect the growth of the plants which were in full flower. The fungus was fruiting on the stems and on and near the midribs of the leaves.

II. ASCOMYCETES

DASYSCYPHELLA VITIS (Schw.) Rehm.

This interesting fungus has seldom been collected since its record by Schweinitz. It is probably not an uncommon species, and was picked up in three widely separated localities in Penn-

sylvania during the 1940 collecting season.   The first of the three
collections was verified by Miss Cash of the Division of Mycology,
who pointed out the similarity of the fungus to *Erinella miniopsis*
(Ellis) Sacc.   The spores were measured as 80–90 $\times$ 2.5 μ.   They
are at first multiguttulate and then multicellular.   The habitat is
the dead outer bark of living trunks of *Vitis*.   All of the collec-
tions were made in June.

MOLLISIA PTERIDINA (Nyl.) Karst.

In pulling up the dead and overwintered leaf bases of *Dicksonia
punctilobula,* a small white Discomycete, scarcely as much as 200 μ
diameter, sessile or attached by a very short stem, was discovered.
Miss Cash later determined it as probably referable to the above
name.   The spores are 5–7 $\times$ 1.5–2 μ, 1-celled, and hyaline.   The
name has apparently not previously appeared in the American
literature.   The collection was made May 20, 1940, in Stone Creek
Kettle, Huntington County, Pa.

MOLLISIA REVINCTA ALBO-PALLIDA Rehm.

On June 11, 1940, I collected rather abundantly a small Disco-
mycete which Miss Cash determined for me as fitting the descrip-
tion of the above species and variety.   It was growing on the
bases of dead raspberry canes in a moist ravine near Salladas-
burg, Lycoming County, Pa.   The following notes were made:

Apothecia crowded or scattered, sessile, not erumpent, 1–2 mm.
broad, externally minutely pubescent with a slightly brownish
pubescence, the disk with margin elevated at first, then plane,
isabelline to light avellanaeous; asci 40–50 $\times$ 5–7 μ, cylindric-
clavate, sessile, 8-spored; spores biseriate, hyaline 1-celled, some-
times slightly curved, 9–12 $\times$ 2.5–3 μ; paraphyses simple, fila-
mentous, about 2 μ diameter, neither strongly enlarged nor con-
spicuously pointed at the apices.

The species has not previously been recorded from America.

MYCOSPHAERELLA TYPHAE (Lasch) Lindau.

On dead leaves of *Typha latifolia,* Carbon Twp., Lackawanna
County, Pa., Oct. 15, 1935.

Perithecia amphigenous, non-maculicolous or producing only a slight blackish discoloration in the immediate vicinity of the scattered perithecia which are black, globose, 60–70 μ diameter, with a thin but distinct blackish wall; asci 30–36 $\times$ 10–12 μ, 4-spored; spores narrow-elliptic, smooth, hyaline, 2-celled, 11–13 $\times$ 4–4.5 μ.

The fungus grew intermixed with a *Cladosporium* and was found only near the tips of the leaves.

PECKIELLA GEOGLOSSI (Ellis & Ev.) Sacc.

This species may be more common than this first collection of mine would indicate. It first forms a mold-like growth over its host and in this stage is a *Verticillium* with oblong conidia that are hyaline, 1-celled, 10–16 $\times$ 5–6 μ. The mycelial mat then becomes more compact and forms a subiculum (stroma?) on which perithecia are produced, seemingly almost superficially. Ascospores 9–14 $\times$ 3–4 μ. The fungus is reported by Seaver as occurring in New Jersey and New York. It was collected in the Forbes State Forest, Westmoreland Co., Pa., Aug. 1, 1940. The deformation of the host, while considerable, allows the maturing of the ascospores so that the host species can be determined. Seaver describes appendaged spores for the genus *Eleuthromyces,* in which he places this fungus. Careful examination of many spores, especially in the younger stages, does not substantiate this character. I take it to belong better in *Peckiella,* where Saccardo referred it, in spite of the nearly or quite superficial perithecia. Neither does my material show one to three spores on the conidiophores, as Rabenhorst states, but always a single spore on each.

PEZICULA RHODODENDRICOLA Rehm.

On dead *Rhododendron maximum,* Stone Creek, Huntingdon Co., Pa., July 5, 1920. J. W. Groves made this determination and states that this is the first American material he has seen. Apparently this is the first report of the species from America.

SPHAERULINA TAXICOLA (Peck) Berl.

The following notes were made from two collections on *Taxus canadensis* on Roaring Branch, Lycoming Co., Pa., April and May,

1938. The earlier collection was immature; the latter mature. The fungus was originally described from New York. The affected needles were dead but yet on the plant, and the appearance was that of a parasite.
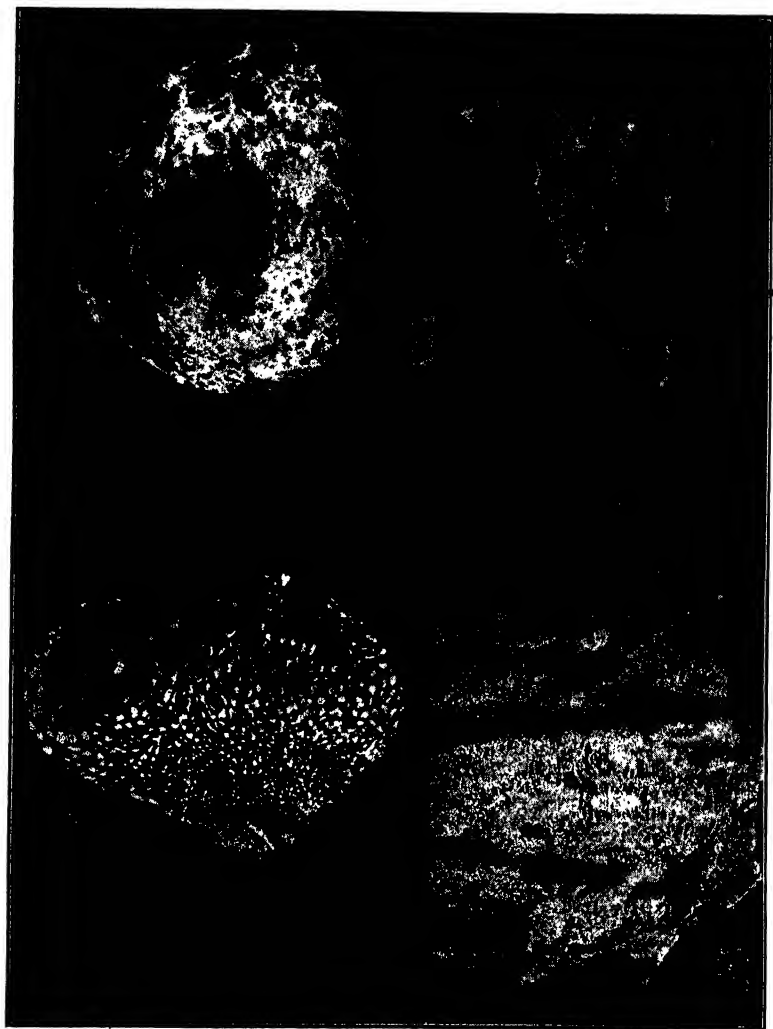
FIG. 1, *Tuber candidum,* surface and sectional views of the ascocarps (× ⅔); 2, *Poria grandis,* type specimen (× 1); 3, *Pisolithus tinctorius,* sessile form of the species, lateral view of vertical section, showing peridioles (× ⅔).

Perithecia abundant, crowded, epiphyllous, black, 80–100 μ diameter, definitely subepidermal or cortical in position, with a well developed black wall; asci 60–80 × 12–14 μ; spores biseriate, hyaline, 4-celled, the ends pointed, 18–20 × 10–12 μ; paraphyses none.

The species is apparently rare in Pennsylvania.

TUBER CANDIDUM Hark. (FIG. 1).

The finding of a species of this family is an event in the lives of most mycologists. Hence it was with great surprise and pleasure that two specimens were discovered on the mossy bank of a small mountain stream in Center County, Pa., in October, 1939. The specimens were larger than the usual records for this species, the largest being 6.5 cm. diameter. The fruiting bodies were only about half-imbedded in the soil.

BASIDIOMYCETES

UREDINALES

PUCCINIA KUHNIAE Schw.

Arthur reported in 1934 that it was doubtful if *P. Kuhniae* occurred in Pennsylvania, though much earlier reported by Schweinitz. Since it was known that Schweinitz made a trip to the vicinity of Hope, Indiana, and since the rust is known from that region and had never been collected east of about that point, it was postulated that Schweinitz had erred in attributing a collection from that region to a Pennsylvania locality. However, in 1939, the rust was collected in quantity on *Kuhnia eupatorioides* near Pleasant Gap, Center Co., Pa., by J. P. Kelly and H. A. Wahl. Though this does not substantiate specifically the Schweinitz record, it makes it seem much more probable.

UROMYCES ANDROPOGONIS Tracy.

In a 1929 rust bulletin by Kern et al. it was stated that this rust was known from Pennsylvania only from the collections of Schweinitz. At Benezette, Elk Co., Pa., it was collected in 1940 on *Viola striata,* which is also an unreported host for it in Pennsylvania. The aeciospores are definitely smaller than those of

Puccinia Violae and *P. Ellisiana* from which *U. Andropogonis* is otherwise indistinguishable in the aecial stage.

AGARICALES

FISTULINA PALLIDA Berk. & Rav.

This interesting and rare species was collected on the campus of The Pennsylvania State College by J. W. Sinden, Oct. 30, 1939. This is the only specimen I have ever seen. It was immature, but duplicates almost exactly Atkinson's Plate 65, figure 2. Apparently it cannot be mistaken for the common species, *F. hepatica.*

PISOLITHUS TINCTORIUS (Pers.) Coker (FIGS. 3, 4).

This interesting and unique species is reported by Coker only from North Carolina, South Carolina, Florida, and Alabama. It was collected on the campus of The Pennsylvania State College in September 1939 by Morton Lange of Denmark. The identification was verified by Coker. On July 11, 1940, another collection was brought in by J. W. Sinden. The former collection was of the sessile type; the latter was rather distinctly stalked.

Poria cognata sp. nov.

Effused in patches 6–10 mm. or more broad, scarcely separable except in small pieces, somewhat nodulose but probably because of the irregularities of the substratum, the sterile margin and sterile subiculum pale yellow, submembranous but inclined to be somewhat cheesy; subiculum distinct but thin, up to 0.5 mm. thick as seen in sections; pore surface cream-color to gray when fresh, becoming more sordid and isabelline with a slight yellowish cast when dry, the tubes oblique, up to 5 mm. long where best developed, often shorter, the mouths often gaping, thin-walled, entire, averaging 2 to 3 per mm. or larger in the gaping types; spores short-cylindric, the ends pointed, smooth, hyaline, $5-6 \times 2 \mu$; cystidia none; subiculum hyphae densely interwoven, not staining well, somewhat branched, $2.5-3 \mu$ diameter, probably with cross walls and clamps but these very indistinct; taste bitter.

Type collected on stump of *Castanea dentata,* on the trail to Mt. LeConte from Gatlinburg, Tenn., Aug. 15, 1939.

Poria grandis sp. nov. (FIG. 2).

Broadly effused, soft-membranaceous, separable, at first entirely pale sulphur-yellow, the sterile margin and subiculum remaining so in dried specimens, elsewhere pale avellaneous or grayish on drying, with small yellowish mycelial strands that penetrate the rotten substratum; subiculum tissue evident, soft, tough, yellow; tubes not more than 1 mm. long, yellow within, the pore surface at first
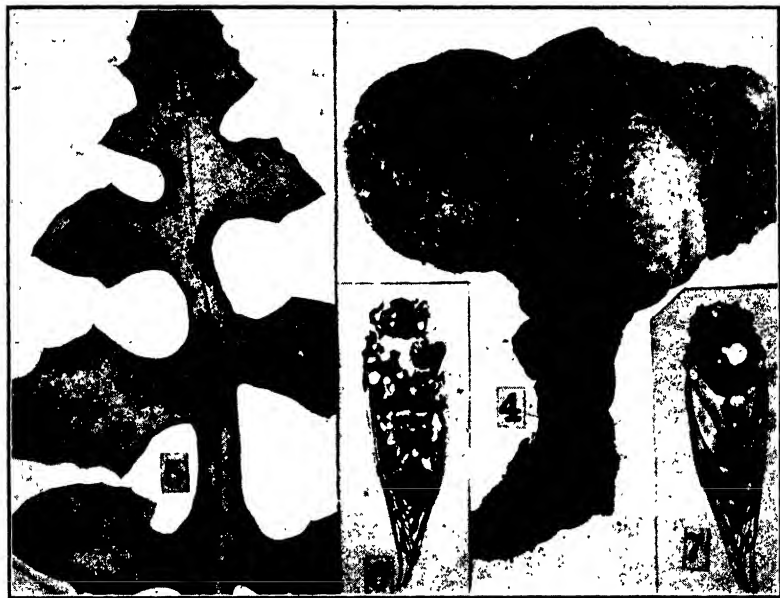
FIG. 4, *Pisolithus tinctorius*, surface view of a stalked sporophore ($\times$ ⅗);
5, *Asteroma Lactucae* ($\times$ 1); 6, *Beauveria globulifcrae*, ventral view of
cicada and fungus ($\times$ ¾); 7, top view of cicada and fungus ($\times$ ¾).

pale yellow, whitening at maturity, but on drying becoming isabelline, the pores obliquely gaping or more regular, angular, thin-walled, entire, averaging about 3 per mm.; spores ellipsoid to broadly ellipsoid, smooth, hyaline, $3–4 \times 2–3 \mu$; cystidia none; hyphae of subiculum $3–4.5 \mu$ diameter, all thin-walled, septated and clamped.

Type collection from the under side of much rotted logs of coniferous trees, near Gatlinburg, Tenn., in the Great Smokies National Forest, Aug. 19, 1939. Collected by J. A. Stephenson.

FUNGI IMPERFECTI

ARTHROBOTRYUM ATRUM Berk. & Broome.

This fungus is well represented in Saccardo's Fungi Italici, figure 12. I get no more than a suggestion that the large central part of the spore is separated into two cells by a septum. Also, it is difficult to tell whether the hyaline stalk cell is a part of the spore or not. I marked the substratum in the field as the stem of *Sambucus canadensis,* but if it is that species, the host died at a very early stage in its growth in the spring. The collection was made in the Great Smokies National Forest, near Gatlinburg, Tenn., Aug. 15, 1939.

ASTEROMA LACTUCAE J. J. Davis (FIG. 5).

Apparently not much is known about this fungus. Superficially it gives the appearance of black anastomosing veinlets but under the lens this character is less distinctive. There is no necrosis of the leaf tissue (at least at this stage) and the black reticulum is present on both leaf surfaces but better developed on the upper than on the lower surface. No fruiting bodies are present and Dr. Davis described the same condition for his collection. It was collected on living leaves of *Lactuca* near the Pennsylvania-Maryland state line on U. S. Route 40, July 15, 1938. The determination was made by J. A. Stevenson.

BEAUVERIA GLOBULIFERA (Speg.) Picard (FIG. 6, 7).

Each year an infestation of the 17-year locust occurs I have watched closely for evidences of fungi on their dead bodies. In the summer of 1940 such an infestation of the locusts appeared over certain areas of central Pennsylvania. In September a single specimen was found infected with a white mold that proved to be this species of fungus. It formed white superficial .pads of mycelium, 0.5–2 mm. diameter, particularly in the thorax region, but more or less over the whole body. Spores globose or nearly so, 1.5–2.5 μ diameter, hyaline, one-celled. Collected at Ross Run, Huntingdon Co., Pa., Sept. 1, 1940.

CORNULARIA HISPIDULA (Ellis) Sacc.

This species illustrates how easily a common fungus may be over-looked year after year until accident flashes it before the eye in such a way that it cannot be ignored.   On the morning of June 16, 1940, I stopped the car along the highway near Trout Run, Pa., and stepped into the woods with collecting basket.   A shower a few hours before had left the woods dripping.   The early morning sun put the lighted side of tree trunks in sharp relief.   Before me stood a living *Nyssa sylvatica* sapling with trunk covered with small black spine-like fruiting bodies of a fungus that was later identified as *Cornularia hispidula*.   Other nearby saplings of the same species were likewise covered by it.   A few days later I looked for it at my mountain cabin on Ross Run, Huntingdon Co., Pa.   A *Nyssa* sapling within 20 feet of the building was the first location for it and later it was substantiated as present generally in the region.   However, the fungus is common apparently only on trees of a certain age, or at least with a certain stage of roughening of the bark.   On older rougher barked saplings it has not been found and likewise its absence from smooth barked individuals has been substantiated.   Saplings about one to one and a half inches in diameter seem to be most preferred.   The species has since been found over a wide area in Pennsylvania.   It was originally de-scribed from New Jersey (as *Sphaeronema*).   The spores are elongate, usually slightly curved, attenuate at both ends but much more so at one end than at the other, 8–9-celled, the tip cells colorless, the others brownish, $60–80 \times 4–4.5 \mu$.

LEPTOTHYRIUM KELLERMANI Bubak.

On dead overwintered leaves of *Sassafras officinale*.   Stone Creek, Huntingdon Co., Pa., April 30, 1940.

Pycnidia amphigenous, scattered, appearing as minute black disks, $120–160 \times 40–50 \mu$, the walls thick and black; conidiophores hyaline, $15–20 \times 1.5–2 \mu$; conidia minute, bacilliform, hyaline, 1-celled, $3.5–4 \times 0.75 \mu$.

It does not seem impossible that this is the spermagonial stage of some species of *Mycosphaerella,* perhaps *M. Sassafras* Ellis & Ev.

Myxosporium castanicolum sp. nov.

Acervuli scattered, erumpent, surrounded by the broken epidermis, up to 640 μ diameter as seen in sections, from the surface view appearing much smaller, internally with a broadly conic mound of stromatic tissue that is fertile on the outer surface; spores elongate-ellipsoid, smooth, hyaline, 1-celled, 24–28 $\times$ 9–11 μ.

Type collected on dead twigs of *Castanea mollissima* at Hamford, Conn., and communicated to me by T. T. Ayers (Overholts Herbarium *21609*).

If Peck's spore measurements of *M. castaneum* Peck are correct, this fungus could not be referred to that species.

NAEMOSPORA ALNI Allesch.

This was collected on dead *Alnus* branches in Stone Creek Kettle, Huntingdon Co., Pa. The specimens were determined by W. W. Diehl. Apparently the fungus comes in quickly after the death of the host. The collection was made on May 20 and the branches of the host had been broken off during the preceding winter. The pycnidial cavities were overlaid by what seemed to be young stromata of an Ascomycete but no asci had yet been formed. This is probably the first report of this species for Amercia. The spores are somewhat smaller than reported in the literature,· measuring 8–9 $\times$ 1.5–2 μ.

PERICONIA PYCNOSPORA Fres.

This interesting fungus, almost unknown from America, was picked up in Elk Co., Pa., June 17, 1940, on overwintered dead stems of *Eupatorium purpureum*. The fungus answers the description in almost every detail. Conidia 11–14 μ diameter, with considerable evidence that they are formed in chains, as noted in Lindau's description in Rabenhorst's Kryptogamen-Flora.

PHYLLOSTICTA NYSSAE Cooke.

Though spots have been noted on leaves of *Nyssa sylvatica* for many years, no fungus responsible for them has been seen by me until this year. The following notes were made:

Spots 5–12 mm. diameter, circular, more conspicuous from above than from below, at maturity dull gray brown with a broad purplish red margin; pycnidia minute, 45–60 μ diameter, epiphyllous, numerous, black; conidia minute, cylindric, bacilliform, 3–3.5 $\times$ 1 μ.

The description of the spots as given by Seaver is not adequate, and spores with the measurements he gives would not likely be described as "ellipsoid to sub-ellipsoid." It may be the spermatial stage of some Ascomycete rather than a valid *Phyllosticta*.

Sporodesmium Peziza Cooke & Ellis.

A *Sporodesmium* collected in Westmoreland Co., Pa., on dead *Acer rubrum* (decorticated) in 1940 was determined as this species by D. H. Linder. Apparently the same fungus as the above was described by Peck a year or two later as *Septonema bicolor,* as acknowledged by Peck. A characteristic dark red coloration in KOH has not been previously mentioned for this species. The spores are in chains and all stages in development are shown in my collection, from the colorless few-celled condition to the dark multicellular condition. They therefore vary greatly in size up to 80μ in length and 40 μ in width. The clusters of conidia and conidiophores form discomycete-like bodies up to 0.5 mm. diameter on the surface of decorticated wood.

Stilbella acerina sp. nov.

Inhabiting spots in conjunction with *Phyllosticta acericola,* the coremia epiphyllous, about 1 mm. high, erect, dark brown, 20–40 μ diameter below, enlarged at the apex to as much as 120 μ diameter, fertile only at the tip; spores elliptic, smooth, hyaline, 1-celled, 4–5 $\times$ 2–2.5 μ.

On living leaves of *Acer rubrum.* The type specimens were collected at Gatlinburg, Tenn., near the entrance to the Great Smokies National Park, Aug. 18, 1939.

Stilbella Hamamelidis (Van Hook) comb. nov.

A collection of this species was made in Forbes Forest, Westmoreland Co., Pa., on leaves of *Hamamelis virginiana,* Aug. 2, 1940. The fungus simulates *Gonatobotryum maculicolum* as

viewed under a lens but the spots are different. Microscopically they are, of course, easily separated. It was originally described as a *Graphium* and there is some question of its proper generic position. The hyaline spores and hyaline hyphae making up the upper part of the coremium indicates *Stilbella* as does also the production of spores in a mass of mucus—*i.e.*, a small droplet at the apex of each conidiophore. The brown hyphae making up the lower part of the coremium argues for the genus *Graphium*. Few if any species of *Graphium* are parasitic on leaves. Van Hook's species seems to have not yet been compiled into the Sylloge. I am indebted to W. W. Diehl for confirming my own opinion on the identity of the fungus. Van Hook says the fungus occurs in Indiana, Ohio and New York.

State College, Pa.

NOTES AND BRIEF ARTICLES

The Mycological Collections of the Bureau of Plant Industry, including the C. G. Lloyd Mycological Collection, have been moved from Washington to new, permanent quarters at the Bureau of Plant Industry Station, located 13 miles north of the Department of Agriculture Buildings in the District of Columbia, on the Baltimore-Washington Highway near Beltsville, Maryland. The collections as part of the Division of Mycology and Disease Survey are housed on the ground floor of Building 5. The Field Station is accessible from Baltimore and Washington by two bus lines and from the latter city by interurban. It is of course readily reached also by those so fortunate as to be able to drive their own cars. The collections with supporting indexes have been arranged and are available for consultation and study.—J. A. STEVENSON.

HAPLOSPORANGIUM BISPORALE

Thaxter,[1] in 1914, described a new genus, *Haplosporangium*, with two species, *H. bisporale* and *H. decipiens,* the first species being characterized by two spored sporangia, the second by one spored sporangia. The species *H. bisporale* is of interest because in so far as the writer knows it is the only species with two spored sporangia, and in the fact that no other record of its occurrence has been reported.

While culturing out ground squirrel dung which had been collected at Rocky Arbor State Park, Wis., for the purpose of obtaining any *Mucorales* present, I noted a small fungus growing in the maze of other molds which produced strands of very fragile hyphae which were fertile for long distances. Along these free hyphae many short sporangiophores arose bearing minute sporangia, some of which were branched others were not. The points of attachment of the sporangia were very small, the bases of the

[1] Thaxter, R. New or peculiar Zygomycetes 3: *Blakeslea, Dissophora,* and *Haplosporangium* Nova Genera. Bot. Gaz. **58**: 353–366. 1914.

sporangiophores were very large.   This immediately reminded one of the figures given by Thaxter for his *Haplosporangium bisporale*.   Upon examination it proved to be this species.

It was readily isolated by picking off mature sporangia on to various kinds of agar.   On both corn meal and potato dextrose agar sporulation was slow and very scanty to none.   However on Czapeck agar though growth was very scanty many spores were rapidly produced.   Still more successful was potato dextrose agar to which rat dung was added, this produced much aerial growth and a great deal of sporulation.

Mycelium on these various kinds of media is white, delicate, consisting of fertile and sterile portions, the fertile portions seem chiefly to be aerial producing many sporangiophores for a long distance, or in other places only one to a few sporangiophores may be present.   The sporangiophores arise on all sides from the main hyphal strand and at right angles to it.   Strands bearing sporangiophores show numerous constrictions dividing it into segments.   Sporangiophores are 66–36 μ in length, the average 48 μ, width at the base from 4–9 μ, on the average 7.5 μ, the tips about 1 μ, and often bent backward, usually with one or two branches, the branchlets short and very small at more or less right angles to the main sporangiophore.   Single spored sporangia 11–7.25 μ, sporangia bearing two spores, 12–14 μ.   The bisporus sporangia in water mounts show a distinct surrounding membrane, the two spores at first are flattened on one side in the sporangium, however, upon release from the sporangium they tend to round up and take on an oval shape.—C. W. HESSELTINE.

NOTE

Persoon, C. H.   Icones Pictae Specierum Rariorum Fungorum. Paris et Strasbourg.   1803–1806.   4°.   64 pp.   24 tab.

In Bibliographical Contributions from the Lloyd Library (vol. 3, No. 2, pp. 54, July 1917) the above publication is listed by C. G. Lloyd as one of the three rarest of Persoon's works.   Only five American mycological libraries are known to possess complete copies of it.   Recent correspondence has revealed that others have imperfect copies lacking the fourth fascicle, composed of pages

45–64 and colored plates 19–24. In order to complete a copy at Cornell University lacking the fourth fascicle, the photographer of the Department of Plant Pathology, Mr. W. R. Fisher, has copied the indicated missing pages and plates. Kodachrome films have been used for the colored plates, and, from these, color prints from wash-off relief film have been obtained. Both the pages of the text and the plates have been made full size suitable for binding with the first three fascicles of the original. The cost has not proved excessive and has been shared by two other institutions to whom prints have been provided. We are willing to make additional sets of prints for others at a reasonable price. As the negatives will be discarded after a few months, it is urged that librarians interested examine their copies promptly. Requests for prints or additional information should be addressed to:

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MYCOLOGIA

THE STATUS OF SEPTORIA ALOPECURI AND SOME RELATED SPECIES [1]

RODERICK SPRAGUE [2]

(WITH 1 FIGURE)

Karsten originally listed *Septoria Bromi* Sacc. var. *Alopecuri* Karst. on *Alopecurus pratensis* L. from Finland (**3**, p. 151). In Karsten's inadequate description, the pycnidia were listed as 80–100 μ diameter, not in spots, with dilutely flavid spores, 58–65 × 2.5–3 μ. The fungus, therefore, had definitely stouter spores than *S. Bromi* Sacc. to which it very evidently shows no great similarity (**6**). P. Sydow (**8**, p. 138) raised the variety to species rank. He said that the spots were obsolete to elongate, pycnidia numerous, black, 80–100 μ; spores bacillar, pluriseptate, rather obtuse, hyaline to dilutely yellow, straight to slightly curved, 50–65 × 2.5–3.5 μ, on *Alopecurus aequalis* Sobol (*A. fulvus* J. E. Smith). H. Sydow very kindly sent the writer a fragment of this collection (Myc. March. *4,871* Zehlendorf, near Berlin, German, Aug. 3, 1896). It appears that the fungus is close to *Hendersonia crastophila* Sacc. (**4**). This species was originally described by Saccardo (**4**, p. 211) as having two forms: "1. *Phragmites com-*

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munis: stylosporis bacillari-fusoideis, utrinque rotundatis, 35 × 5.5, 7–8-septatis, eguttulatis, fuligineis.   2. *Cynodontis dactyli:* stylosporis similibus, 35 × 4." Later, Saccardo (5, p. 438) designated the former as *H. crastophila* Sacc. and the latter as "var. β *Cynodontis dactyli";* both with descriptions, including spore measurements, as above.

Most of the European and American material otherwise assignable to *Hendersonia crastophila* has 7-septate, fusoid brown spores, usually 40–60 × 3–4.5 μ, but which are sometimes narrower, depending on the host or stage of development.   Sydow's specimen has narrower spores than most of *H. crastophila* (FIG. 1, D, E, F). Sydow's material that we examined has spores 40–49 × 3.4–4.2 μ, and, therefore, shorter and wider than the measurements given by Sydow.   It is possible, therefore, that the portion we saw was not typical of the fungus he was discussing.

Karsten's type is not available and there is no way of telling from his description whether he had a true *Septoria, Phaeoseptoria* (7) or simply a phase of *Hendersonia crastophila.* The evidence indicates that his fungus was more likely an undeveloped *Hendersonia.*   The lack of evident lesions, the size of the pycnidia and the yellow spores are all indicative of developing *Hendersonia* material.   However, we have recently encountered material on grasses from the United States that may be related to Karsten's fungus, but which are logically assigned to *Septoria.*

C. L. Lefebvre sent material of *Septoria Andropogonis* J. J. Davis on *Andropogon furcatus* Muhl. collected at Manhattan, Kansas, which had 2 to 3-septate hyaline to yellow, obclavate spores 33–51 × 3.2–3.9 μ (FIG. 1, B).   Davis' type (1) has spores 30–50 × 2–3 μ, but otherwise was like Lefebvre's collection. Davis' species has spores that range in size below those of *S. Alopecuri,* but possibly has spores similar to those Karsten saw. We have another collection on *Sporobolus heterolepis* A. Gray, which is very similar to *S. Andropogonis* and which we are designating a new form, as follows:

Septoria Andropogonis Davis forma sporobolicola forma nov.

Spots oval to sub-elongate-elliptical, small, 1–3 mm., scattered in living, vigorous leaves, white to straw colored with narrow but well defined anthocyaninred borders, pycnidia 2 to several in each

spot, strongly erumpent, almost superficial, pale brown, thin-walled, somewhat elongate but depressed-globose, ostiolate, 120–150 × 100–140 μ; pycnospores hyaline but becoming yellow in saprophytic stage, contents with few small, not prominent, guttulae more or less adjacent to the cross walls, basal cell tapering, blunt or sub-truncate spores stiffly curved or nearly straight,
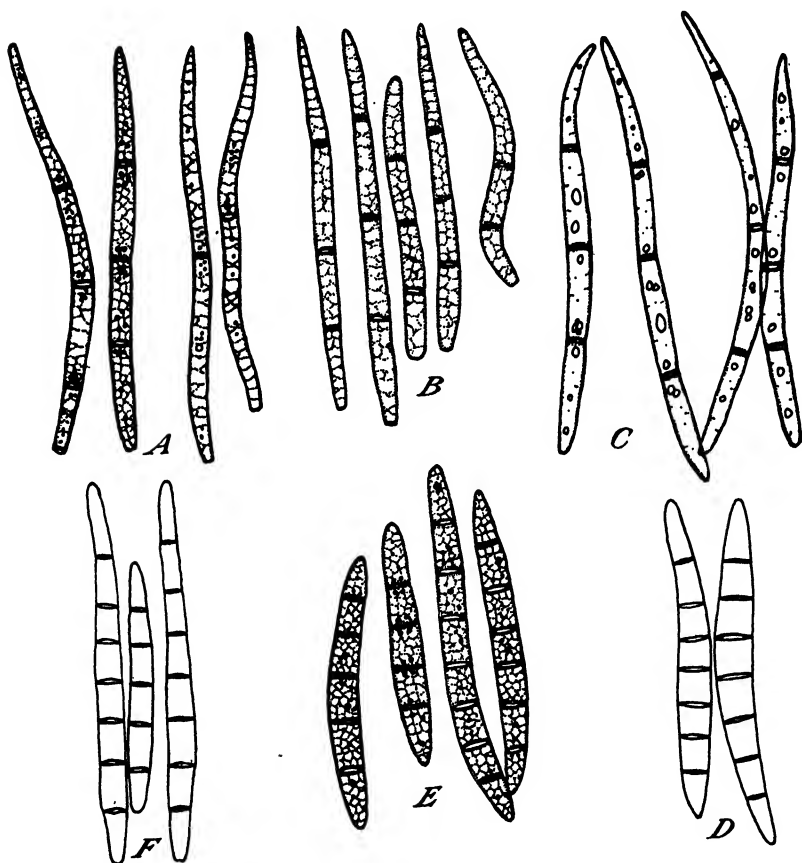
Fig. 1. *A, Septoria Andropogonis* Davis f. *sporobolicola* on *Sporobolus heterolepis* near Lisbon, N. Dak. 1939. (Watson coll., Mandan N-1818); *B, S. Andropogonis* Davis on *Andropogon furcatus*, Manhattan, Kansas. (C. L. Lefebvre coll.); *C, Septoria mississippiensis* on *Muhlenbergia mexicana*, Lake Itasca at head-waters of Mississippi river, Minn. (Type); *D, Hendersonia crastophila* Sacc. on *Calamagrostis canadensis* var. *scabra*, Seward, Alaska; *E, H. crastophila* on *Agropyron Smithii*, Clyde, N. Dak.; *F, Septoria Alopecuri* (Karst.) Sydow on *Alopecurus aequalis* (Myc. March. *4871*, Berlin, Germany). All × 1000.

obclavate, apex sharp-pointed, 45–51 × 2.4–3.4 µ; spores typically about 50 × 2.6 µ in spot material, broader in saprophytic material, 3-septate.

On living leaves of *Sporobolus heterolepis* in Land Utilization project near Lisbon, N. Dak., Sept. 15, 1939, collected by Welland A. Watson (Mandan *N-1818*) (*B.P.I. 80,859*). This form differs from the species in having larger pycnidia and smaller, more or less circular nonstriate lesions. On the basis of present knowledge, f. *sporobolicola* is nothing more than a morphological form of *S. Andropogonis*, but host range studies are needed to determine physiological relationship.

Another specimen on *Muhlenbergia mexicana* (L.) Trin., which has spores 35–65 × 2.1–3.1 µ, may be even closer to *S. Bromi* var. *Alopecuri*. Considering the confusion about Karsten's fungus, it is considered better to recognize the fungus on *Muhlenbergia mexicana* as an undescribed species as follows:

Septoria mississippiensis sp. nov.

Maculis orbiculatis v. elongatis, flavo-brunneis, margine brunneo, pycnidiis paucis, sub-gregariis, subcarbonaceo-parenchymaticis, erumpentibus, ostiolatis, parvulis, nigro-brunneis, 100–113 µ; pycnosporulis hyalinis v. chlorinis, clavulato-filiformibus, apicibus subacutis, basibus subobtusis, 3-septatis, guttulatis, 35–65 × 2.1–31. µ.

Hab, in foliis vivis *Muhlenbergiae mexicanae* (L.) Trin., Lake Itasca, Minn. Type is *B.P.I. 80, 857*.

This material consists of only a few but well defined buff eyespots with prominent brown borders on the sheaths and leaves of living or sometimes necrotic leaves of this host. This fungus is possibly a phase of *Phaeoseptoria Festucae* f. *Muhlenbergiae* Spr. (7), but this is unlikely because the spores of *S. mississippiensis*, which appear to be mature or nearly so, are much paler and narrower than the *Phaeoseptoria*. The lesions are distinct and the pycnidia of the *Septoria* smaller with thinner walls. *S. mississippiensis* is, as mentioned, possibly close to *S. Bromi* var. *Alopecuri* but certainly not to *H. crastophila* (cfr. FIG. 1, A–F). Our fungus is named for the Mississippi river from whose very headwaters this specimen was obtained in 1941. Recently a second collection of *S. mississippiensis* on *M. asperifolia* (Nees and Mey.) Par. (*B.P.I. 80,858*) was obtained near New Rockford, N. Dak.

The several forms of *S. Alopecuri* first discussed by Trail (**9**) and enlarged on by Grove (**2**) are discussed in a companion article to this on the genus *Phaeoseptoria* (**7**) to which genus these forms are transferred.

Again the aid of A. G. Johnson and Edith Cash in the final preparation of the manuscript is gratefully acknowledged.

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LITERATURE CITED

1. **Davis, J. J.**   Notes on parasitic fungi in Wisconsin—1.   Wisc. Acad. Sci. **18**: 78–92.   1915.
2. **Grove, W. B.**   British stem- and leaf-fungi (Coelomycetes) Sphaeropsidales. **1**, 488 pp. illus.   Cambridge.   1935.
3. **Karsten, P. A.**   Symbolae ad mycologiam fennicam XVI.   Medd. Soc. Faun. Fl. Fenn. **11**: 148–161.   1884.
4. **Saccardo, P. A.**   Fungi Veneti novi vel critici vel mycologiae Veneti addendi, VII.   Michelia **1**: 133–221.   1878.
5. ——.   Sylloge Fungorum **3**: 562.   Pavia.   1884.
6. **Sprague, R.**   *Septoria* diseases of Gramineae in the Western United States. (In ms.)
7. ——.   The genus *Phaeoseptoria* on grasses in the western hemisphere. (In ms.)
8. **Sydow, P.**   Beitrage zur kenntniss der Pilzflora der Mark Brandenburg II.   Hedwigia (Beiblatt) **38**: 134–140.   1899.
9. **Trail, J. W. H.**   Revision of Scotch Sphaeropsideae and Melanconieae.   Scot. Nat. (N.S. v. 3) **9**: 219–236.   1888.

NEW STATIONS FOR TWO FUNGI

DAVID R. SUMSTINE

(WITH 1 FIGURE)

In collecting fungi in the State of New York during July, 1942, I found a rust near Bemus Point on *Potentilla recta* L. which proved to be *Phragmidium Ivesiae* Syd. Dr. Frank D. Kern of Pennsylvania State College confirmed the determination. Dr. Kern, after receiving my specimens, examined some of the host plants growing in the vicinity of State College and found them infected with the same rust. This rust is reported in the North American Flora only from the western part of the United States. *Potentilla recta* is not given as a host. It appears that these collections extend the range of this rust to the eastern part of the United States and add another host to the list.

In September, 1940, I found a number of dark brown sclerotia under some shrubbery in Schenley Park. These were evidently exposed by recent heavy rains. The place was frequently visited during the remainder of 1940 and during the year 1941 but no fruiting bodies appeared. In September, 1942, an abundance of sporophores were found not only in this particular place but also in other nearby places. The first few plants pulled up showed long root-like strands. Through curiosity I dug up some of the plants to find the place of attachment and discovered that all the plants were attached to sclerotia. (See FIGURE 1.) This collection numbers over 150 plants. Did these plants continue for two years in the resting stage?

From the published descriptions and the illustrations this plant agrees with *Naucoria arvalis* var. *tuberigena* Quél. (1). Lloyd (2) described *Naucoria scleroticola* as a new species from specimens received from West Virginia but suggested that it may be *Naucoria semiorbicularis* growing from a sclerotiun. Later (3) at the suggestion of Lange he decided that his new species was the same as *Naucoria arvalis* Fr. which at times develops sclerotia. Hennings (4) described a new species under the name *Naucoria*

tuberosa which Singer (**5**) transferred to another genus, *Agrocybe tuberosa* (Henn) Singer.   Singer (loc. cit.) gives a very good description of the species.   He cites Quélet's var. *tuberigena* as a synonym.
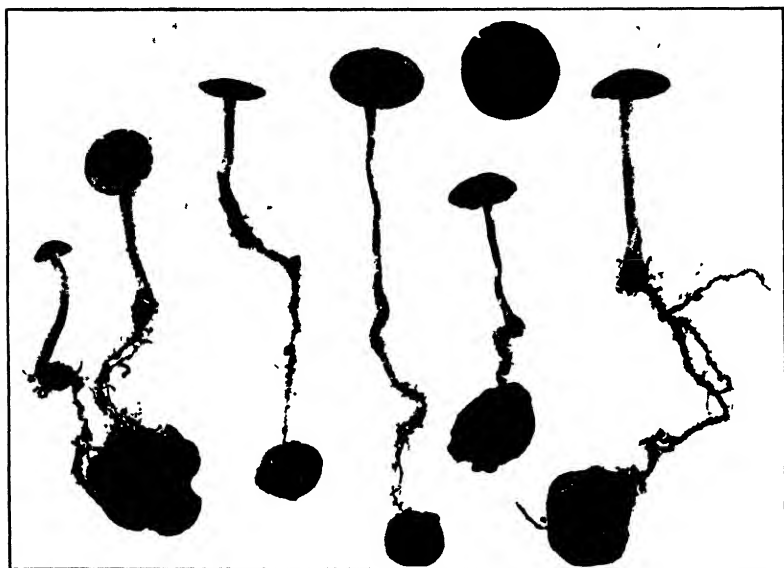
FIG. 1.   Sporophores of *Naucoria tuberosa* attached to sclerotia, one-half Natural size.

It seems that the following names have been given to this plant:

Naucoria arvalis var. *tuberigena* Quél. (1889)

Naucoria tuberosa Henn. (1903)

Naucoria scleroticola Lloyd (1917)

Agrocybe tuberosa (Henn) Singer (1942)

Murrill in the North American Flora does not recognize this species.

The Pittsburgh specimens are given as a new station for this interesting plant.

The photograph from which the plate was made was taken by Sydney Prentice of the Carnegie Museum.

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LITERATURE CITED

1. **Quélet, L.**　Assoc. Fr. Av. Sci.　Compte Rendu **18.**　1889.
2. **Lloyd, C. G.**　Mycological Notes **5**: 722.　1917.
3. **Lloyd, C. G.**　Mycological Notes **5**: 753.　1917.
4. **Hennings, P.**　Hedwigia **42** Beiblatt: 311.　1903.
5. **Singer, Rolf.**　Lloydia **5**: 133.　1942.

CONSERVING NAMES OF FUNGI

C. L. Shear

Having just had an opportunity to peruse Dr. Donk's article (4) on the conservation of generic names, I am moved to make a few remarks on what may be considered an already threadbare subject. However, as long as a few curious people, even in time of war, persist in pursuing and naming the lowly fungi and cannot seem to agree on any simple and rational method of choosing their names, perhaps further discussion may be justified.

In recent years considerable progress has been made by international botanists toward the stabilization of generic and specific names. The type method of fixing such names has been generally adopted and also the conservation of our common and well known generic names. The conservation of specific names seems equally desirable. It is being urged by some of our English colleagues and we hope it may be provided for in the next revision of the code.

It has taken much time and effort to get these principles accepted. Our chief problem now is to find some more practical plan for selecting and typifying generic names. Many of us have apparently become so attached to the priority plan that it is difficult to give it up even in special cases. Before it was agreed to make exceptions to the almost sacred law of priority we could not agree on a starting point, and so long as we make priority the major principle in the choice of names, and in addition fix various dates for the starting points of various groups of fungi, we cannot hope to reach any great degree of uniformity or stability in the choice and application of names, even after a great amount of bibliographic and herbarium work under the most favorable library and herbarium facilities, has been carried out. That priority with its multiple starting points is the cause of much confusion and waste of time and effort in reaching any satisfactory conclusion by the present plan is most forcibly and convincingly illustrated by Dr. Donk's discussion of *Corticium* (4, p. 164–7) as well as other generic names. Persoon (9), who first used the

name in 1794, had a rather definite idea of the group, in which he included six species. Three of these species have since been transferred to *Peniophora* Cooke (3), and one to *Aleurodiscus*. The other two, *C. roseum* and *C. laeve*, have been treated as good species of *Corticium* by nearly all mycologists down to the present time. Very little was added in the way of more exact definition of the genus until about 1890, when the advent of more careful and thorough microscopic studies added much to our knowledge of the morphology of the fungi and provided the basis for a more definite and natural conception of the genus.

The group of fungi under consideration, whether you call it a genus or put it in some other category, has been evolving through millions of years to reach its present condition and character. The taxonomic concept of mycologists has been evolving for about one and a half centuries. Persoon's concept and the species he included was much more in accord with recent concepts, (for example, Burt's (1)), than the vague and confused application of the name by Fries, which reached its climax in his latest treatment (8), where he included seventy-five species, representing a half dozen or more different genera, according to recent authors. This case might be cited as an example of the evolution of a generic concept in reverse. Donk in an earnest effort to follow the rules which require all genera of Hymenomycetes to start with Fries, after much labor and doubt as to where and when Fries validly published the genus according to the provisions of the present code, decides on Floram Scanicam 1835 (5), but as no species were mentioned there he must go on to Genera Hymenomycetum, 1836 (6) where a few species are listed. But in order to get a type species which would fix the name as it is commonly applied at present, he has to go still farther, to the Epicrisis, 1838 (7). Thus we have all this labor and maneuvering in order to attribute the name to Fries and still recognize Persoon by the clumsy formula "Pers. ex Fries." It is difficult to see what useful purpose has been served by all this expenditure of time and labor.

The opponents of conservation claim that it is impractical. If all this trouble is necessary their claim is justified. When or by whom many of the older genera were really established in their present usage and concept can scarcely be determined with cer-

tainty.   This condition of affairs is strikingly illustrated by most of the cases which Donk discusses and should be sufficient to convince any fair-minded mycologist of the futility of trying to save our present names by appealing to priority, especially when based upon various starting points which do not cover some of our well known names coming from earlier authors.   The name *Corticium* is Persoon's, the concept and the species it includes are the result of various changes made by various authors which are not covered by "Persoon ex Fries" but more completely by *Corticium* Auct. Misc.   If one is interested in the evolutionary vagaries of the mycological mind and the detailed history of the use and abuse of some of our common generic and specific names of fungi, such studies as these of Dr. Donk may be justified, but to require them as a preliminary to the typification and conservation of a common and well known name like *Corticium* is a great waste of time and a reflection on the mental capacity of mycologists.

Now let us approach the problem from another angle.   Dr. Donk and many other mycologists agree that it is important to conserve as far as is practicable the present names of our well known and widely distributed genera.   Why not admit that Persoon, who was the first to use the name *Corticium* and whose definition and application was much more consistent and more nearly in accord with present usage than that of Fries, was the first to name the genus?

· Why worry so much about who shall be given credit or discredit for having proposed a generic name, as in most cases of the older genera no single author really defined the genus according to its present concept and its final definition, if ever agreed upon, will probably involve the work of yet unborn mycologists.

Instead of so much stress on dates and priority, a much simpler and more rational plan of attaining the desired result in conserving generic names would be to first determine what names should be conserved and what species should be selected as their types, in order to bring most of the species now generally included under a particular name together.

Take *Corticium* for example.   Let us forget for the moment, priority and authority.   It is proposed to hold this name against all other names whatever their claims may be.   Next, what group

of species is at present included under this name by most authors and which of these species is well known and fairly typical of the group? If the present group of species still includes any of those listed by the original author of the name, in this case Persoon, the one most typical of the present group should be chosen. According to this plan, *C. roseum* Persoon was chosen by Clements and Shear in *The Genera of Fungi* (2), as up to the present time most authors have regarded it as a good *Corticium*, but now Dr. Donk concludes (4, p. 166) that this species represents a genus distinct from the bulk of the present species of *Corticium* and therefore another type must be chosen. Very well, there is still another good species of Persoon in the present genus—*C. laeve*. Why not take it and settle the case at least until someone proposes to found a new genus on that species? Our only hope, apparently, for more than temporary stability, depends upon how far the present tendency of the so-called splitters to multiply new genera will go. Let us hope that our genera will not eventually all become monotypic.

Instead of the simple procedure we have just proposed, we must, according to the rules, bring Fries into the case in order to validate and establish the name. Dr. Donk after a rather brave and lengthy struggle selects *C. confluens* Fries as the type of the genus to be held until some way can be found to validate Persoon's name according to the rules. Thus after all this labor we still have perhaps only a temporary type for the genus. If further examples of the impracticability of the present plan are necessary in order to convince one of the great need of a revision of the rules and the elimination of the Friesian starting point, they are amply provided in the other cases treated by Dr. Donk in the paper cited.

With all our vaunted pride in liberty and freedom we still find it difficult to free ourselves from the habit of bowing obsequiously to so-called authority. Credit to whom credit is due, but blind following of authority when it impedes the advancement of science can scarcely be justified. We are glad to recognize Fries as a great and good mycologist, but why make an idol of him and declare that no name published before him shall be used without his sanction, and the wasting of time, space and paper by such

clumsy citations as "Persoon ex Fries"? This carries the assumption that Fries had the same thing as Persoon and that this has been verified by comparison of Persoon's and Fries' specimens. There appears to be no good reason, therefore, why he should be given credit for or held responsible for all the names of earlier authors which he happened to adopt. We once contended (10) and still believe that if we must have a nominal fixed date as a starting point for generic nomenclature Tournefort would be the most just and logical. Tournefort, Micheli, Battarra, Schaeffer, Bulliard, Persoon and other pre-Friesian authors have given us generic and specific names which are still current and should be recognized whether they happen to have been adopted or approved by Fries or not. If we have a single starting point for both genera and species, Linnaeus is the least objectionable. The major effort should be to conserve names by a simple method of selecting types which will fix them in accord with the best present usage whether they were first proposed by Tournefort, Micheli, Persoon or some other author.

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LITERATURE CITED

1. **Burt, E. A.** The Thelephoraceae of North America. XV. *Corticium.* Ann. Mo. Bot. Garden **13**: 173–354. 1926.
2. **Clements, F. E. & Shear, C. L.** The Genera of Fungi. 496 pp. 1931.
3. **Cooke, M. C.** On *Peniophora.* Grevillea **8**: 17–21. 1879.
4. **Donk, M. A.** Nomina generica conservanda and confusa for Basidiomycetes (fungi). Bull. Bot. Garden Buitenzorg III. **17**: 155–197. 1941.
5. **Fries, E. M.** Corpus florarum provincialium Sueciae. I. Floram Scanicam scripsit. 394 pp. 1835.
6. ——. Genera Hymenomycetum quorum novam expositionem. 17 pp. 1836.
7. ——. Epicrisis systematis mycologici. 608 pp. 1836–38.
8. ——. Hymenomycetes Europaei sive Epicriseos systematis mycologici. 756 pp. 1874.
9. **Persoon, C. H.** Neuer Versuch einer systematischen Eintheilung der Schwämme. Römer's Neues Mag. f.d. Bot. **1**: 63–128. 1794.
10. **Shear, C. L.** Generic nomenclature. Bot. Gaz. **33**: 220–229. 1902.

GOUIRAND AND BERGERON'S TREATMENT OF SPHACELOMA AMPELINUM

Anna E. Jenkins and A. A. Bitancourt

(WITH 1 FIGURE)

Arnaud and Arnaud (**2**), in 1931, and Puttemans (**12**), a few years later, alluded to the revival of the old form genus *Sphaceloma* DeBary (**4**). A revised description of this genus, which is typified by *S. ampelinum* DeBary (**4**), has been published recently (**10**). At the same time the description of the ascomycetous genus *Elsinoë*, technically typified by *E. Canavaliae* Rac.[1], was emended with mention of *Sphaceloma* as the conidial stage. *S. ampelinum*, now classified as *E. ampelina* (DeBary) Shear (**14**), is, of course, best known as the cause of grape anthracnose; as such, it is widely illustrated in literature dealing with diseases of the vine.

Generally unfamiliar to mycologists is the graphic account of *Sphaceloma ampelinum* published in 1897 by Gouirand and Bergeron (**6**, *figs. 1–7*). Their interesting line cuts are not cited in Saccardo's *Index Iconum Fungorum* (**13**), in which the organism appears under the binomial *Gloeosporium ampelophagum* (Pass.) Sacc. To increase the availability of the illustrations just cited, which make clearer an understanding of certain aspects of the life history of the organism, particularly with respect to conidial formation, they have been photographed and assembled on the accompanying Plate (FIG. 1, A–G), with the original legends given in full. A recent article by du Plessis (**11**) illustrates similar conidial development.

Gouirand and Bergeron were concerned primarily with the action of certain fungicides on the grape pathogene in a resting condition. They refer to Viala and Ravaz (**17**) as having stated that the fungus passes the winter in concentrated mycelial masses in the cankers, which in spring give rise to conidia. These growths are termed "sclerotia" by Gouirand and Bergeron.

[1] This species is illustrated by Arnaud (**1**, *pl. 3, A–D.*).

They describe (**6**, p. 5–6 and Figs. 1 and 2) a stem canker in autumn, both in its general appearance and in section. They also depict (**6**, p. 6–7 and Figs. 3 to 5) the sclerotia in different stages of development and the manner of conidial formation from them in the spring. In the laboratory this process was conveniently followed by placing thin sections of dormant sclerotia in drops of water suspended on a cover slip inverted over a culture cell (**6**, p. 7–8 and Figs. 6 and 7).

Jaczewski (**7**),[2] who cites Gouirand and Bergeron, states that the sclerotia of *Sphaceloma ampelinum* become evident at the close of summer. He explains that they correspond to the conidial layers that have reached a period of rest, therefore, do not form conidia. He adds that he has observed this transformation under natural conditions, and continues: "In the spring the hymenial layer of conidiophores is again produced." According to him these sclerotial formations are retained in the old wounds for several years, forming annually a new hymenial layer of conidiophores on their surfaces. Illustrations of sclerotial masses are shown by Viala and Pacottet (**15, 16**) who credit Goethe (**5**) with having first observed them. The old conidial layer is apparent on the mature sclerotial development illustrated by Gouirand and Bergeron (**6**, *fig. 5*). This structure, acting as a sclerotium, corresponds closely to the conidial stage of *Elsinoë australis* Bitancourt and Jenkins as illustrated elsewhere (**3**, *pl. 25, C–F*).

Doubt was expressed by Gouirand and Bergeron, as well as by others, as to whether more than one spore can be produced from a conidiophore of *Sphaceloma ampelinum*. There is probably little question that the several detached conidia shown in their figure 7, *e*, were reproduced successively from the conidiophore there shown. Similar conidial formation is illustrated for *Elsinoë Fawcettii* Bitancourt and Jenkins both in culture (**9**, *fig. 7*) and in nature (**8**, *fig. 4, G*). DeBary (**4**), who described the formation of young conidial fructifications of *S. ampelinum*, mentioning the short pointed hyphae (conidiophores), stated that conidia were produced abundantly when young lesions were brought in contact with water. A conidial fructification from nature showing num-

erous conidia, illustrated by Briosi and Cavara, is here reproduced (FIG. 1, H).

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LITERATURE CITED

1. **Arnaud, G.** Les Astérinées, IVe partie. (Études sur la systématique des champignons pyrenomycetes). Ann. Sci. Nat. X. **7**: 643–722. 1925.
2. **Arnaud, G. & Arnaud, M.** Traité de pathologie végétale I. 2 1505. 1931.
3. **Bitancourt, A. A. & Jenkins, A. E.** Ciclo evolutivo de *Elsinoë australis* Bitancourt e Jenkins, agente da verrugose da laranja doce. Arq. Inst. Biol. (São Paulo) **10**: 129–146. 1939.
4. **Bary, A. de.** Ueber den sogenannten Brenner (Pech) der Reben. Ann. Oenol. **4**: 165–167. 1874.
5. **Goethe, M. R.** Mittheilungen über den Schwarzen Brenner und den Grind der Reben. 38 p. Berlin and Leipzig. 1878.
6. **Gouirand, G. & Bergeron, G.** Observations sur le traitement de l'anthracnose. Rev. Vit. **7**: 5–10. 1897.
7. **Jaczewski, A. A.** Antraknoz i khloroz. (Anthracnose and Chlorosis.) Trudy Biuro Mykol. i Fitopat. 9, 67 p. 1911.
8. **Jenkins, A. E.** Development of the citrus-scab organism *Sphaceloma fawcettii*. Jour. Agr. Res. **42**: 545–558. 1931.
9. ———. Comparações culturaes e inoculações em videira com os fungos *Elsinoë fawcettii*, *E. ampelina*, e *E. veneta*. Arq. Inst. Biol. **7**: 23–32. 1936.
10. ——— & **Bitancourt, A. A.** Revised descriptions of the genera *Elsinoë* and *Sphaceloma*. Mycologia **33**: 338–340. 1941.

FIG. 1, *A–G.* *Sphaceloma ampelinum* DeBary. (After Gouirand and Bergeron (6)). The letters *A–G* correspond to their figures 1 to 7, of which the legends are quoted below: *A* (1). "Aspect d'une lésion d'anthracnose pendant l'hiver: *scl*, sclérote formant une bordure noire autour du chancre." *B* (2). "Coupe à travers un chancre d'anthracnose ayant détruit l'écorce et une portion du bois; *b*, bois; *rm*, rayons médullaires; *fp*, faisceaux de fibres péricycliques; *c*, cuticule; *l*, lames de liège tendant a preserver les tissus sousjacents; *scl*, sclérotes à differents états de développement, très développés à droite, plus jeunes à gauche; *m*, filaments mycéliens isolés." *C* (3). Sclérote à son premier état de développement: *scl*, cellules de sclérote; *e*, épiderme; *c*, cuticule." *D* (4). "Sclérote plus avancé ayant déchiré la cuticule *c*, et pénétré dans les cellules de l'épiderme, *e*." *E* (5). "Sclérote complètement formé: les cellules sont très brunes a l'extérieur, d'une teinte moins foncée a l'intérieur; au bas, on voit le mycélium non condensé." *F* (6). "Sclérote dont quelques cellules commencent à émettre un prolongement, *b*." *G* (7). "Formation des spores sur les filaments nés du sclérote: *a*, *b*, *c*, *d*, *e*, états successifs."

H. Sphaceloma ampelina, after Briosi and Cavara, I funghi parasiti delle piante coltivate od utili. Fasc. 4, no. 96, fig. 3. 1889.
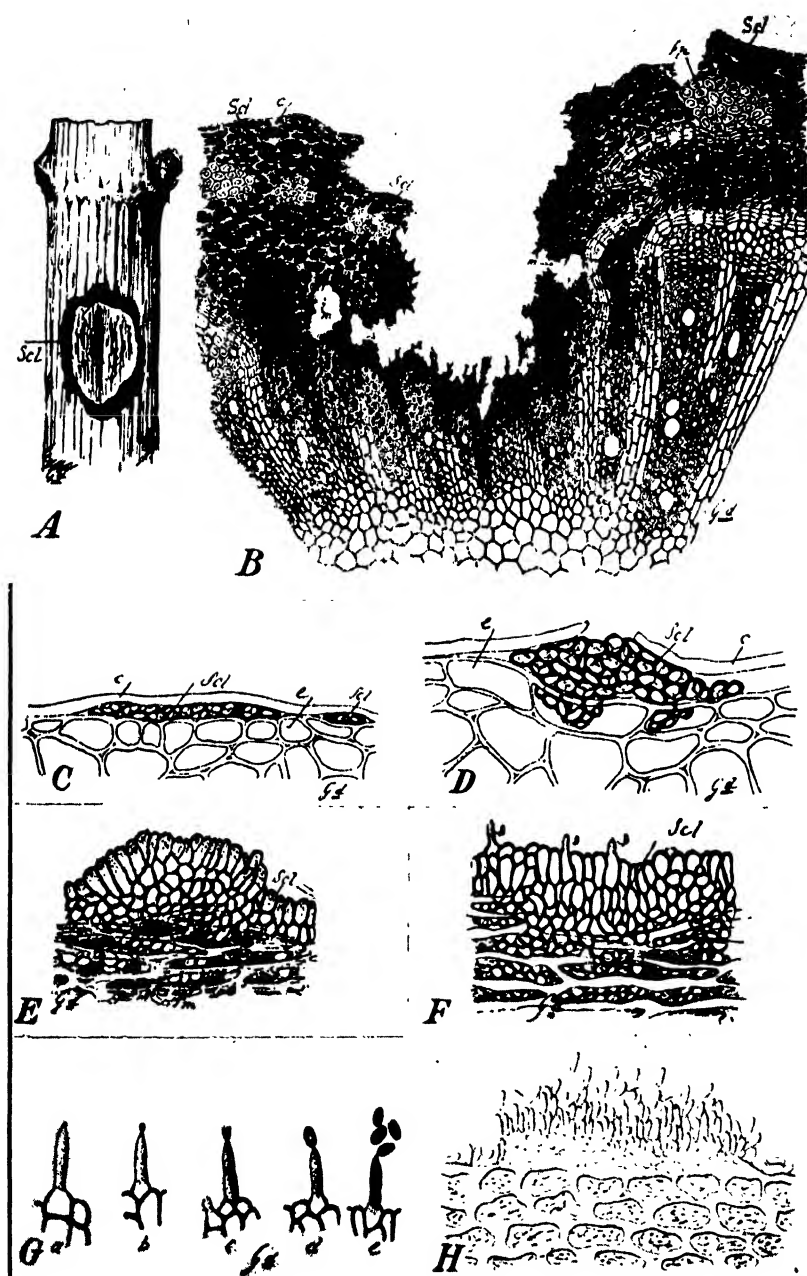
Fig. 1.

11. **Plessis, du, S. J.** Anthracnose of vines and its control in South Africa. Dept. Agr. and Forestry (Stellenbosh Series No. 40) Union of South Africa. Sci. Bull. 216, 47 p. 1940.

12. **Puttemans, A.** Ligeira contribuição a phytopathologia brasileira. O Campo **5**: 20-25. 1934.

13. **Saccardo, P. A.** Index Iconum Fungorum. Sylloge Fungorum **19**: 768–769. 1910.

14. **Shear, C. L.** The life history of *Sphaceloma ampelinum* de Bary. Phytopathology **19**: 673–679. 1929.

15. **Viala, P. & Pacottet, P.** Nouvelles recherches sur l'anthracnose. Rev. Vit. **24**: 657–663. 1905.

16. ——. Recherches sur l'anthracnose. Rev. Vit. **25**: 89–91. 1906.

17. **Viala, P. & Ravaz, L.** Recherches expérimentales sur les maladies de la vigne. Compt. Rend. **106**: 1711–1712. Jan.–June 1888.

SOME BASIDIOMYCETES FROM MOUNT SHASTA

WM. BRIDGE COOKE

During my residence of three summer months of each of six years at timberline on Mt. Shasta, a Cascade Range peak located in southern Siskiyou County, California, I have found several common, unusual, rare, or hitherto unknown Basidiomycetes. Of these, several are worthy of notice from the point of view of habitat, frequency of occurrence, interesting structure, or novelty.

In the vicinity of the Shasta Alpine Lodge the forest includes almost exclusively the Shasta Red Fir, *Abies magnifica* var. *shastensis* (5). The Lodge is at the upper limits of the Canadian Zone and the lower limits of the Hudsonian Zone (9). The former zone on the southwest side of the mountain consists in the main of Shasta Fir, and the latter zone consists in the main of White Bark Pine, *Pinus albicaulis*. Because of edaphic conditions the mycobiota of the Shasta Fir forest is much richer than that of the White Bark Pine forest (6). This is also true of the sub-shrub layer composed of *Arctostaphylos nevadensis*. The area has been untouched by fire and only since 1922 has the axe entered it, and this sparingly in the use of young trees for timbers and in the use of dead trees for firewood. The logs which have been studied have all fallen from natural causes; avalanche, windstorm, heart rot and root and butt rot being the commonest of these.

As the snow line recedes up the mountain from an average of 3000 feet to above timberline the logs become exposed to the desert-like atmosphere of the drying winds. Apparently under the cover of the snow fungus activity can be carried on. As soon as the drying winds start this activity appears to cease. However, within the larger logs the rotting activities of numerous micro-organisms can be carried on, for it takes a long time for these logs to dry out. In any event the time taken for the complete decay of logs is long, for fallen timber in at least one ava-

lanche area is still in a fair state of preservation, although not all of each log is usable for fire wood, more than twenty years after the avalanche flattened the forest as if it were a handful of match sticks. In contrast to this condition is the condition of trees which have fallen as a result of the weakening effect of heart rots, such as *Fomes officinalis*, *Fomes pinicola*, *Fomes subroseus*, *Porodaedalea Pini*, and others, and of butt and root rots such as *Armillaria ?mellea*. These trees fall during high winds with most terrifying sound. They quickly disintegrate both as a result of continued saprobic activity on the part of the primary cause of their downfall and as a result of numerous secondary and possibly even tertiary rots. It is to these groups of fungi that our attention is drawn. They are usually found by removing the layer of bark on the fallen trunk which protects the sapwood and heartwood from drying out in the hot dry summer winds. When this layer of bark is absent the sapwood forms a protecting layer around the moist heartwood. These fungi are not always found in only this habitat, since some also occur on pieces of structural wood or fire wood in use around the Lodge outbuildings from the stable to the kitchen.

HETEROBASIDIOMYCETES

TREMELLACEAE

1. TREMELLODON GELATINOSUM (Scop. ex Fries) Pers. ex Fries.

During the summer of 1939 several collections of this fungus were made. It was found inside of and in cracks between cubical rot chunks of prostrate Shasta Fir logs well protected from the dry air. The fructifications were much smaller than those found commonly in the moist coastal forests of California and Oregon. Collections in the Herbarium at the University of California indicate that this is an unusual habitat, at least in California, for this species.

DACRYMYCETACEAE

2. GUEPINIOPSIS ALPINUS (Tracy & Earle) Brasfield.

This is the commonest Basidiomycete on Mt. Shasta. It occurs on dead sticks and rotting logs throughout the Shasta Fir

forest as well as on debris of *Tsuga Mertensiana* and *Pinus albicaulis* (and possibly on other hosts).   It is common on posts, timbers and hand-hewn boards on the wood buildings around Horse Camp.

HOMOBASIDIOMYCETES

THELEPHORACEAE

3. SOLENIA CANDIDA Pers.

This interesting species is found occasionally on the underside or on the inside of rotting logs in the vicinity of timberline near Horse Camp.   It has been seen so far only on Shasta Fir.   A colony may be as large as a yard long and several inches wide.

4. ALEURODISCUS DIFFISSUS (Sacc.) Burt.

> *Peniophora diffissa* Sacc.
> *Aleurodiscus succineus* Bres.
> *Aleurodiscus sajanensis* (Murashk. in Litt.) Pilát.

Fructifications appearing at first sight of two types: a type which grows as a *Peniophora* in a continuous patch on the underside of twigs and apparently completely resupinate; and a type which appears at first glance like thin fructifications of *Stereum frustulatum*.   However, on closer inspection it is seen that the first type is merely a manifestation of the luxuriant growth of the second type.   In certain conditions the separate fructifications of the species, as indicated by their points of attachment seen in older, curled-up examples, may join at the edges and form sheets; again, under certain conditions the individual fructifications may continue to grow close together for several seasons, as indicated by the several layers of hymenia on top of each other, without fusing, thus appearing in close-growing instances to have broken apart (the basis of the specific name).

Hymenial cells large, $54 \times 9\,\mu$, staining deeply with phloxine, no fertile basidial cells seen although many of the cells seen may have been basidial initials; later these cells, or cells like them as well as narrow cells one-third as wide, bear one of more acanthophyses which are $9–27 \times 7–8\,\mu$ with appendages in whorls or

spirals of 4–5 rows around a central axis 1.8–4.5 μ wide, appendages 2–4 $\times$ 0.9–1.35 μ; pseudophyses occur in older specimens, rarely in young material, mostly found in collections made on *Arctostaphylos patula*, rare in collections from a higher elevation on *A. nevadensis*, 60–70 $\times$ 9 μ; no spores seen in several mounts from several collections. As many as 10 layers of zones carrying acanthophyses occur in older specimens; 1–2 layers are common in all collections. Acanthophyses are easily separable from what apparently are mother cells which may have one to many additional appendages but in scattered order; axes of separable portions of acanthophyses variable in thickness, some appearing ellipsoid to tubular, others lance-like; some of the staining cells appear to cut off by septation one to several of these acanthophyses which cover the hymenium, giving it a silky sheen in certain light; these separable structures remain uncolored by phloxine and in their normal position on the hymenium, where they appear to form a sort of epithecium, are penetrated only by the pseudophyses. A subhymenial structure of simple type was observed throughout all mounts.

The species is common on dead sticks of *Arctostaphylos nevadensis* found *in situ* in patches of the host which form large carpets in forests of Shasta Fir and on the borders of these forests throughout the southwestern slopes of Mt. Shasta, particularly near economic timberline. It also occurs on dead sticks of *Arctostaphylos patula* on the ground in the upper humid Transition zone.

It is interesting to note that the species has hitherto been known only from rather fragmentary collections. These collections, as well as those mentioned above, have been made only from hosts belonging to the Ericaceae. Bresadola's *A. succineus* was collected by Weir in Oregon from *Arbutus Menziesii*. Bresadola (2) found no mature spores in this material. The other host on which this species has been reported is *Rhododendron dahuricum*. In the writings of Saccardo, Murashinsky, Burt (3), and Pilát this species has been described from two collections from Manchuria and Siberia. D. P. Rogers, as well as the writer, could find no spores in the Shasta material. However, he reports, in a letter to the writer, that the spores of Murashinsky's collection are cylindric, even, strongly amyloid, and measure 17–18 $\times$ 5.5–6.5 μ.

5. ALEURODISCUS AMORPHUS (Pers.) Rab.
   Aleurodiscus Grantii Lloyd.

Fructification small, rarely more than 2 mm. in diameter, some-times two or more confluent and then up to 5 mm. across; pink in color, with white margin and underside, hairy, when dry ex-tremely patellate, appearing like a small *Dasyscypha*. D. P. Rogers, who examined the material collected by the writer from both *Abies concolor* and *Abies magnifica* var. *shastensis*, reported that the roughenings on the walls of the spores could be brought out only with iodine in the material collected on *A. concolor*, while that collected from the other host showed markings in KOH; Dr. Rogers also reported that the pseudophyses, usually abun-dant in relatively sterile specimens, were entirely lacking in my extremely fertile material.

It was of interest to compare my material macroscopically with other California collections on file at the University of California and determined by H. S. Jackson.   This material was collected by Parks in the Trinidad area of the California coast.   In size it was much larger, confluent patches attaining a width of over 1 cm. and single fructifications being rarely less than 2 mm. across. Material from *Pinus muricata* was mostly yellow in color while that from *Abies grandis* had narrower white margins and was more buff in color with only a slight trace of pink.

6. Aleurodiscus fruticetorum W. B. Cooke, sp. nov.

Appearing like a *Stereum* in habit and in cross section; margin reflexed up to 0.5–1 cm., white to gray, hirsute above; with an orange, waxy hymenium, orange-yellow when dry, covering a white tissue; hymenium composed of basidia, cystidia and acan-thophyses; cystidia are deeply staining structures (in KOH and phloxine), obtuse-clavate, $80–117 \times 7.2–10.8 \mu$, which extend $18–25 \mu$ beyond the hymenium and are densely guttulate; acan-thophyses scattered through the hymenium are easily confused with the basidia because of their identical size, of several sorts (possibly stages in development): those with a few appendages at the extreme tip of the cell, those with the appendages scattered to crowded over the top $5–10 \mu$ of the cell, and those with the appendages scattered over the upper quarter and the upper and middle quarters of the cells; basidia $60–70 \times 7–9 \mu$, with sterig-mata $7–7.5 \times 2–2.5 \mu$; spores evenly ellipsoid-cylindric, smooth-walled, hyaline, not amyloid, abundant, $10.8–12.6 \times 5.4–7.2 \mu$.

Stereo habitu et sectione transversa simulans, margine usque ad 0.5–1 cm. reflexo, albo vel griseo, super hirsuto, trama alba, hymenio ceraceo, colore aurantio vel siccato demum flavo-aurantio, cum basidiis, cystidiis acantho-physibusque, cystidiis obtuso-clavatis 80–117 × 7.2–10.8 μ, supra hymenium 18–25 μ longe exsertis et dense guttulatis; acanthophysibus per hymenium sparsis, basidiis multo similibus propter formam, basidiis 60–70 × 7–9 μ, sterigmatibus 7–7.5 × 2–2.5 μ; sporis ellipsoideo-cylindraceis, laevibus, hyalinis, non amyloideis, numerosis, 10.8–12.6 × 5.4–7.2 μ.

Collected on *Arctostaphylos patula* and *Ceanothus velutinus* twigs and sticks in a patch of chaparral at 6000 feet on Mt. Shasta near Wagon Camp, Aug. 18, 1941, *WBC 15731*—Type; and *15732*.

The specific name was chosen because of its association with both dominants of the secondary Shasta chaparral. It was included in this genus on the recommendation of D. P. Rogers. The basidia and spores are too large for *Stereum*, and the de-scribed cystidia which originate as gloeocystidia are not found in *Stereum* species. The hyphae, while forming a waxy hymenial area, do not gelatinize and so keep the species out of *Cytidia*. Although there is no mineral matter in this species it is therefore included in *Aleurodiscus*.

7. PELLICULARIA FLAVESCENS (Bon.) Rogers.
    Botryobasidium ochraceum (Mass.) Donk.

Among a collection of molds sent to Dr. Linder.for identifica-tion this species had crept. It grows on rotten wood on the in-side of Shasta Fir logs. It has been collected here but once.

8. STEREUM RUGISPORUM (Ellis & Ev.) Burt.
    Hymenochaete rugisporum Ellis & Ev.

While *Hymenochaete* is characterized by usually spindle-shaped setae on hyphae originating at various points throughout the subhymenial region and protruding beyond the hymenium, as well as by the presence of a chemical (referred to as thelephoric acid) which turns black and makes the specimen opaque in KOH mounts, this combination of characters is replaced in this species by another combination which, it is suggested, may be related to those of the primitive *Hymenochaete* type. In·*Stereum rugisporum* the spindle-shaped setae are replaced by dark brown hypha-like

structures which originate at different levels throughout the thick subhymenial region as one of two or three series of hyphae which compose the fructification.   These brown hyphae extend beyond the hymenium up to 45–72 μ in our specimens although Burt reported them up to 110 μ.   They have a thick wall until near the tip, which has a blunt point, thin wall, and, in phloxine, red-staining contents.   These cystidium-like structures are not as common in occurrence in the hymenium of material collected on Mt. Shasta on burned Shasta Fir as they are in specimens collected by Bonar on *Abies magnifica* at Gold Lake in Plumas Co. in 1942.   There are at least two series of hyphae in the fructification, one dark brown series giving rise to the cystidia, the other light brown and apparently giving rise to the ultimately hyaline hymenium. There appear to be at least two layers of hymenial areas in sections of the Mt. Shasta material, indicating that at least two seasons of growth were required.   The margins are obtuse and the fructifications thick, as thick as 2 mm. in the Gold Lake material.   On Mt. Shasta the specimens collected have been found only on burned dead logs (burning having been caused by lightning or camp fires).

9. HYMENOCHAETE TABACINA ([Sow.] ex Fries) Lév.

This common thelephore was found on a shrub of *Ceanothus velutinus*.   This shrub is one of the important members of the chaparral which invades burned-over areas on the mountain.   As the normal forest cover returns to these chaparral areas it smothers the shrubs.   This shrub had been smothered by a grove of young trees of *Abies concolor*.   Every prostrate branch of the shrub had sporophores of the fungus, the only time the fungus has been noted on the mountain.

HYDNACEAE

10. CALODON AMICUS Quélet.

A large colony of sporophores of this tough "mushroom" was found along the Sisson Southern Trail under a patch of *Arctostaphylos nevadensis* on Shasta Fir duff in the Shasta Fir forest. It has been included in the writer's exsiccati under the number **56**.

11. ECHINODONTIUM TINCTORIUM Ellis & Ev.

Along the Sisson Southern Trail a mixed colony of *Abies concolor* and Shasta Fir has been infected by this species. It occurs at other points on the mountain but its effects on the forest are most conspicuous here.

MERULIACEAE

12. Serpula americana (Burt) W. B. Cooke, comb. nov.

Merulius americanus Burt.

Fructifications forming large patches up to 10 × 100 cm.; hymenium gyrose-porose, pores up to 5 mm. across and from 0.5–5 mm. or more deep, when deep labyrinthiform, when shallow netlike, more or less irregular; hymenium honey-brown, with a white subiculum which is layered and easily separable from the substratum in large sheets; spores (4.5) 5–6 × 10–11.5 (12.5) μ, light brown in a KOH-phloxine mount, egg-shaped but flattened on one side; when fresh the fructification is more or less fleshy at least in the areas close to the hymenium and heavily infested by a beetle which devours the collection unless carefully fumigated when collected; hyphal layer next to the substratum with hyaline and brown hyphae parallel to the substratum, internal layer appearing to have been partially gelatinized, loosely arranged, parallel to the substratum but without brown hyphae, near the hymenium forming a denser layer perpendicular to the substratum; brown hyphae 5–6 μ in diameter, hyaline-hyphae 3–4 μ in diameter, neither set encrusted but both sets with clamps; spores in several stages of growth on the sterigmata hyaline; sterigmata 7.2 μ, basidia 36 × 7.3 μ.

This species is common on Mt. Shasta and has been collected at a number of stations near economic timberline on fallen logs of Shasta Fir. It has been observed in each of six summers in which collections have been made although it is distinctly annual. Our material differs from that observed by Burt in several points. Burt described his species as being papery rather than fleshy and this may indicate that he did not know the species in the field. However, it is thought that the differences between the two sets of material are not sufficient to warrant the erection of a new species on my collection which has been included in my exsiccati as number 46.

In the writer's report on the generic nomenclature of pore fungi (**8**) the Meruliaceae were not considered except by citation. Since Rogers (**13**) has shown that S. F. Gray's genera are post-Friesian, and since the writer believes that *Merulius* as understood today can be better understood as two genera on the basis of the hyaline (*Merulius*) and colored (*Serpula*) spores, the above disposition of this species is considered valid.

This species has been found twice in California in addition to the Mt. Shasta record as indicated by collections at the University of California.   Mrs. M. R. Gibbons found a small specimen at Badger Flat above Huntington Lake in Fresno Co. on *Pinus contorta* var. *Murrayana*, June 20, 1941.   A second collection, complete with large rhizomorphs, was made from wood on the floor of a private garage in Berkeley on Jan. 26, 1934—this was determined by C. J. Humphrey.

13. MERULIUS BELLUS Berk. & Curt.

Several collections of this interesting fungus have been made in the vicinity of Horse Camp on Shasta Fir logs.   In microscopic characters this material differs from that described by Burt in that clamp connections are common and the fructification is not at all easily separable from the substratum.   The presence of encrusted hyphae and the spore shape and size as well as other characters appear to be quite typical, however.   Collection number *WBC 8564* made on July 7, 1937, has been included in the writer's exsiccati under the number 47.   This material agrees in characters with material collected from an old conifer log on Isle Royale, Michigan, determined by A. H. Povah, and a duplicate of which is deposited in the University of California herbarium. The Mt. Shasta collections are the only ones from California in that herbarium.   In a letter from Dr. L. O. Overholts attention is called to the discrepancies between my material and Burt's description although Dr. Overholts concurred at that time in my use of this name.

14. MERULIUS CERACELLUS Berk. & Curt.

Material referred to this species was collected on an old Shasta Fir log near Horse Camp, at 8500 feet, on July 28, 1938 as *WBC*

10253 and included in the writer's exsiccati as No. *48*. While this species is reported as exclusively frondicolous by Burt, my material answers Burt's description except for the heavily encrusted hyphae. No California material other than this has been referred to this species in the University of California herbarium. Although in neither this nor the above species does the avellaneous subhymenial zone described for these species by Burt, and present in collections in Dr. Overholts's herbarium, occur, Dr. Overholts felt, according to his letter of June 28, 1940, that I was justified in the use of this name for my material.

15. **Merulius atropurpureus** W. B. Cooke, sp. nov.

Older portions of fructification show shallow pores or mere reticulations on a smooth hymenium which is red-pink near the white cottony fimbriate margin to deep blood red in older portions in dry material, salmon to magenta pink when fresh; hymenium becoming black-purple in KOH; subicular hyphae heavily encrusted, 6.3–7.2 μ in diameter, without clamp connections; basidia 18 × 3.6 μ, spores 4.5 × 1.5 μ; long, brown, encrusted cystidia occasional, extending up to 20 μ beyond the hymenium, 35–40 × 4–5 μ. Fructification resupinate, strongly adnate to the substratum, forming large patches up to 2–4 × 5–8 cm.

Resupinatus, adnatus, hymenio primum laevi demum reticulato, margine albo-fimbriato, hymenio in sicco colore obscure sanguineo vel in KOH atropurpureo, tramae hyphis dense incrustatis, non nodososeptatis, 6.3–7.2 μ latis, basidiis 18 × 3.6 μ, sporis 4.5 × 1.5 μ, cystidiis raris, longis, brunneis, incrustatis, 35–40 × 4–5 μ, ex hymenio 20 μ emergentibus.

On Shasta Fir near the Sisson Southern Trail at about 7000 ft., June 17, 1938, *WBC 10117*. Collected only once and then in dense forest.

The specific name was selected because of the striking color of the hymenium in KOH.

16. PHLEBIA MERISMOIDES Fries.
Phlebia radiata Fries.

Fructification strongly adnate, forming large sheets over the substratum; white to pale cream color when fresh, tan to resinous brown when dry with resinous, more or less fimbriate but not definitely hyphal margin; ridges radiating regularly and branching

regularly from centers, with tooth-like projections along the ridges; hymenium composed entirely of 4-spored basidia which bear numerous spores 5.4–6.3 × 1.8–2.7 μ, hyaline, ovate, not allantoid.

WBC 15624, collected on a fallen log of Shasta Fir in woods above Panther Creek meadows at about 8000 feet, July 28, 1941. Issued in exsiccati as No. *128*.

A collection made by Lee Bonar on *Abies magnifica* at Gold Lake, Plumas Co., July 29, 1942, appeared exactly as the above description in the older material. The younger specimens he obtained were sterile but gelatinous, shiny, pale cream to tan, with a hyaline margin which appears to have been gelatinized, is rarely resinous, and is not fimbriate.

POLYPORACEAE

17. AURANTIOPORELLUS ALBOLUTEUS (Ellis & Ev.) Murrill.
Fomes alboluteus Ellis & Ev.
Polyporus alboluteus Ellis & Ev.

The most conspicuous pore fungus on Mt. Shasta as the snow is melting away from rotting logs in the forest is this species. It forms large orange sheets on the under side of rotting logs which still retain their original shape. The fungus is quickly eaten by the beetle *Dacne picea* Lév. and needs quick fumigation, even while drying, to prevent loss of the specimen. The fungus is nearly resupinate although in most cases a comparatively large mass of material which looks like a sponge, and is usually more than 1 cm. thick and 1–2 cm. or more high above the level of the highest tubes, is present. Late in the summer logs on which this fungus has fruited can be distinguished by the piles of reddish fungus remains deposited on the ground by the above mentioned insect.

18. COLTRICIA PERENNIS Fries ex. S. F. Gray.
Polyporus perennis Fries.
Polystictus perennis Fries.
Coltricia connata S. F. Gray.

At a number of stations in several types of habitat this species has been collected at least once a year on Mt. Shasta. It has been

found on rich humus in moist soil at Panther Creek heather meadows, on Shasta Fir duff near springs in the vicinity of Bear Springs, on sandy lava soil in fir forests and in the bed of an intermittent stream in Cascade Gulch. Its elevational range varies from 5000 to 8000 feet in the collections so far made.

19. **Cristella candidissima** (Schw.) Donk in mss. ex W. B. Cooke com. n.
   Polyporus candidissimus Schw.
   Poria candidissima (Schw.) M. C. Cooke.

Of the several species of *Poria* collected on Mt. Shasta this is the most interesting. Its hyaline, asperulate, ovate spores, ampullae, abundant clamp connections and fasciculate basidia set it apart from the others. It also has encrusted hyphae. In the Mt. Shasta material, collected from rotten Shasta Fir logs, several forms of fructification are found. In the simplest, the pores are hardly more than shallow pits, while in the more complex the pores are long, irpiciform tubes, somewhat more floccose but with the same appearance as those of larger specimens of *Polyporus versiporus* (*Poria mucida*) which has not yet been found on the mountain. The affinities of this species, rather than with other species of *Poria* which are really only imperfect forms of the pore fungi, are with the genus *Cristella*, based by Patouillard on a *Clavaria*-like fungus having the above mentioned group of characters. The above combination has been proposed in an unpublished communication by M. A. Donk. The publication of this combination at this time is in line with other efforts at the clarification of the problem of "what is a *Poria?*" under discussion by a number of recent writers (**10**).

20. CRYPTOPORUS VOLVATUS (Peck) Hubbard.
   Polyporus volvatus Peck.
   Cryptoporus volvatus (Peck) Shear.

Common on *Abies concolor*, *Abies magnifica* var. *shastensis*, *Pinus ponderosa* and possibly other trees throughout the entire area of the mountain whether in dense forests or in groves or isolated trees in the chaparral areas. Included in the writer's exsiccati under the number 77.

21. GANODERMA OREGONENSE Murrill.

Occasionally fructifications of this species, or their remains, are found on dead snags, stumps or drying trees of Shasta Fir. These fructifications are noteworthy for their large size, unsurpassed in the herbarium of the University of California, at least. A young specimen found Sept. 8, 1942 measured 8 inches in radius from the top of the stipe-like portion to the actively growing, thick, round front edge, and $6\frac{1}{2}$ inches across at the widest point. The specimen was 4 inches thick with a tube layer, only in the early stages of development, 1 mm. deep. An old specimen was found on the same day which measured 17 inches from the top of the stipe-like portion to the front and 15 inches across the widest portion. The tubes of this specimen showed what appeared to be the result of two seasons of growth and were 1–1.5 cm. long where beetles had not eaten them away. The larger specimen had ceased growth at least one season before these observations were made. The lacquered top appears to develop in successive stages. On the young specimen the lacquering process was apparently complete on the oldest 4 inches while it was still in the process of development on the next 3 inches and apparently absent on the white to cream colored actively growing front region. A similar situation was noted on the older specimen which likewise had no varnish on the growing area although the fructification obviously had not been living within the past season.

22. LENZITES SAEPIARIA (Wulf.) Fries.

On one log of Shasta Fir cut from the forest during the construction of the Everett Memorial Highway this fungus has fruited on the sawed end two years in succession—1941 and 1942, although the log was cut in 1935. It has not been seen elsewhere on the mountain.

23. FOMES OFFICINALIS (Fries) Lloyd.

24. FOMES PINICOLA (Fries) Cooke.

These two species cause most of the heart rot of Fir and other coniferous trees on Mt. Shasta. They have been observed on *Abies concolor*, *Abies magnifica* var. *shastensis* and *Pinus lam-*

bertiana. Doubtless they occur on other hosts. Other fungi cause structural weakening of the larger forest trees (such as *Armillaria* sp.) but in a large percentage of the fallen logs observed the signs and symptoms observed point to the presence of one or the other of these two fungi in the heartwood before the tree had fallen.

25. FOMES SUBROSEUS (Weir) Overholts.

Although other fungi cause most of the heartrot observed on trees of Mt. Shasta this species is observed in fruit on occasional fallen logs and stumps.

26. POLYPORUS ELEGANS [Bull.] ex Fries.

Material sent to W. A. Murrill and determined by him as of this species has been collected three times in the vicinity of Mt. Shasta. It was found once on a rotting burl of *Prunus emarginata* which had been removed in a road widening project near Bear Springs. Again it was found among sticks on a hillside in the Squaw Valley Creek drainage among chaparral in a grove of scattered sugar and yellow pines. Again it was found on the ground under a cover of mature yellow pines and chaparral. It was not found above 6000 feet.

27. CORIOLUS ABIETINUS (Fries) Murrill.
    Polyporus abietinus Dicks. ex Fries.
    Hirschioporus abietinus (Fr.) Donk.

Commonly throughout the Shasta Fir forest this fungus has been found fruiting on old logs, stumps, and newly fallen branches and tree tops. I have seen and collected no typical material. It appears to become aborted, although fertile, either through shortness of growing period caused both by late snows and early drying out of substratum, or through irregularity of the substratum which, in some cases at least, has a definite effect on the shape of the sporophore. No resupinate material has been observed, the atypical form taking on rather a smaller size of pileate fructification. Bonar collected this species on *Abies magnifica* near Gold Lake in Plumas Co., July 28, 1942, where it grew largely in the resupinate habit although occasional aborted pileate speci-

mens were found.   Material from Huntington Lake in Fresno Co. on *Pinus contorta* var. *Murrayana* in 1942 was also like the Shasta material.   In contrast to these collections, on Mt. Diablo, Contra Costa Co., in February, 1942, the species was found on logs of *Pinus Sabiniana* and *Pinus Coulteri* in luxuriant, typical growth although the latter host had sporophores which were black-purple in color of the hymenium.

28. PORIA LENIS Karst.

Found occasionally in small to large sheets on the under side of Shasta Fir logs in the Horse Camp area.   The lunar shape of the spores and the glistening pores which are sometimes slightly colored from white to cream or pinkish are characteristic.   This has been issued in the writer's exsiccati as number *57*.

29. PORIA RUFA (Schrad. ex Fries) M. C. Cooke.

One collection of this fungus was made on a rotting log of *Pinus ponderosa* in the bottom of Bolam Creek canyon on the north side of Mt. Shasta.   .

30. PORODAEDALEA PINI (Fries) Murrill.

This fungus is represented on Mt. Shasta by the red ring rot disease it produces on Shasta Fir as well as by the occasional fruiting bodies found within Shasta Fir logs well on the final stages of decay.   The type of fructification found is a thick, resupinate form of the fungus described under the name of *Trametes Pini* var. *Abietis* Karst.

31. SPONGIPORUS LEUCOSPONGIA (Cooke & Hark.) Murrill.
    Polyporus leucospongia Cooke & Hark.

Throughout my collecting experience on Mt. Shasta this has been a conspicuous member of the polypore group.   It grows on dead wood in almost all stages of decay on Shasta Fir, *Tsuga Mertensiana*, and *Pinus albicaulis*, as well as possibly on other hosts.   It was found once, the only report so far as we have been able to discover on frondose wood, on a decaying stick of *Arctostaphylos patula* in a smothered patch of chaparral in a grove of young firs.   On its normal hosts its lower altitudinal limits ap-

pear to be about 7000 feet.   It is more common on the dead wood
of the higher forests near economic timberline and in the fallen
forests of avalanche areas.   It also occurs on posts used as tim-
bers and as trail markers.   In this last instance it grew on a
coniferous post at an elevation of 9000 feet considerably above the
highest timber along the Summit Trail where the post was used
as a mile post.

32. LAETIPORUS SULPHUREUS ([Bull.] ex Fries) Bond. & Sing.
    Polyporus sulphureus [Bull.] ex Fries.
    Laetiporus speciosus (Batt.) Murrill.

A number of immature sporophores assigned to this species by
their general appearance, structure and consistency were found
growing from the butt and trunk of a dead Shasta Fir in woods
between Horse Camp and Panther Creek, Sept. 8, 1942.   It had
never been observed before on the mountain.   The elevation was
about 7500 ft.

Material of some of the above species has been distributed in
the writer's exsiccati series now totaling 150 numbers.   Material
of all species listed here is in the writer's herbarium at the Uni-
versity of Cincinnati, while material of most of it has been sent
to the University of California, the New York Botanical Garden,
the Farlow Herbarium and the Mycological Collections of the
Bureau of Plant Industry.

The writer wishes to express his appreciation of the assistance
rendered by Dr. Donald P. Rogers of the American International
College during the preliminary studies and preparation of this
paper; to Dr. Lee Bonar for his kind permission to use space and
materials in the Herbarium of the University of California; and to
the Lloyd Library for bibliographic assistance.   Dr. Harry R.
Muegel of the Botany Dept., University of Cincinnati, very
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BIBLIOGRAPHY

1. **Bondarzew, A. & Singer, R.**   Zur Systematik der Polyporaceen.   Ann.
    Myc. **39**: 43–65.   1941.
2. **Bresadola, G.**   New species of fungi.   Mycologia **17**: 68–77.   1925.
3. **Burt, E. A.**   Hymenomycetous fungi of Siberia and Eastern Asia.   Mo.
    Bot. Gard. Ann. **18**: 469–487.   1931.

4. **Burt, E. A.**   Thelephoraceae of North America.   *Stereum.*   Mo. Bot. Gard. Ann.

5. **Cooke, W. B.**   Flora of Mt. Shasta.   Am. Midl. Nat. **23**: 497–572.   1940. First Supplement.   Am. Midl. Nat. **26**: 74–84.   1941.

6. **Cooke, W. B.**   Host Index of Mt. Shasta Fungi.   Pl. Dis. Rept. Suppl. **123**.   1940.   First Supplement.   Pl. Dis. Rept. **25**: 61–62.   1941. Additions.   Pl. Dis. Rept. **26**: 253–259.   1942.   Mimeographed.

7. **Cooke, W. B.**   Mycobiota of North America.   *Fascicles* 1–5.   1939–42.

8. **Cooke, W. B.**   Nomenclatorial survey of the genera of pore fungi.   Lloydia **3**: 81–104.   1940.

9. **Cooke, W. B.**   The problem of life zones on Mt. Shasta.   Madrono **6**: 49–56.   1941.

10. **Cooke, W. B.**   Resupinate pore fungi in Oregon.   Am. Midl. Nat. **27**: 677–695.   1942.

11. **Donk, M. A.**   Revision der Niederländischen Homobasidiomycetae— Aphyllophoraceae.   Bot. Mus. Univ. Utrecht Med. **9**.   1933.

12. **Murrill, W. A.**   North American Flora 9: 1907–08.

13. **Rogers, D. P.**   Relative dates of S. F. Gray's natural arrangement and Fries's systema.   Mycologia **33**: 568–570.   1941.

A DASYSCYPHA FOLLOWING CRONARTIUM RIBICOLA ON PINUS MONTICOLA. II.

RICHARD T. BINGHAM AND JOHN EHRLICH

(WITH 2 FIGURES)

THE DASYSCYPHA ON PINUS MONTICOLA

A small-spored, white-excipled *Dasyscypha* on *Pinus monticola* has in several instances in the past been confused with *D. Agassizii* and *D. calyciformis*. Stillinger (**1929**: 579) reported that in 1924 he had collected *D. Agassizii* on dead branches of *Pinus monticola* in northern Idaho. The specimen (C. R. S. *2221*), originally identified by Dr. Wm. Diehl, on re-examination proves to be the *Dasyscypha* under consideration. Stillinger (**1929**: 580) at the same time reported three collections of *D. calyciformis*, one of which (C. R. S. *2602*), on *Pinus monticola* from British Columbia, has also been re-examined and found to be the same fungus. Referring to these latter specimens, Stillinger (*loc. cit.*) reported the fungus as occasionally found on blister rust cankers. In 1930 and 1931 Goodding and Hansbrough collected the fungus on blister rust cankers in Oregon and British Columbia, Hansbrough determining it to be *D. calyciformis*. It is not surprising that these fungi have been confused since *D. Agassizii* and *D. calyciformis* have not been adequately described until now. (Bingham & Ehrlich **1943**).

The *Dasyscypha* under consideration was first encountered by the writers during the course of a study on secondary fungi associated with blister rust cankers of *P. monticola*. Unlike the other secondary fungi encountered, the fungus was found to be abundant in every established blister rust center inspected in northern Idaho and northeastern Washington. Its present abundance is noteworthy since Stillinger (*loc. cit.*), only eight years after the discovery of *Cronartium ribicola* Fisch. in the Northwest, had reported *D. calyciformis* (in at least one instance actually the *Dasyscypha* in question) as only occasionally found on blister rust

cankers. Now this fungus is common on blister rust cankers in at least part of the region concerning which Stillinger had reported. It would seem that the fungus is endemic and has remained uncommon until the inroads of the blister rust disease have provided it with abundant infection courts in unhealthy and dead bark of *Pinus monticola*.

During the years 1940 to 1942 the fungus has been observed repeatedly, the substratum being in all cases the dead or weakened bark of *P. monticola*. Well over a hundred specimens have been collected and although a conscious effort was made to find this fungus on different substrata and on different hosts the effort has not been successful. Collections other than those made in connection with this study have been examined and found to be consistent in regard to substratum and host.

A description of the *Dasyscypha* on *P. monticola* which follows attempts to point out differences whereby this apparently undescribed fungus may be distinguished from its close, small-spored relatives *D. Agassizii* and *D. calyciformis*. The description is based on detailed study of thirty-five specimens, all but six of them on the bark of blister rust cankers.

THE DASYSCYPHA ON PINUS MONTICOLA.

Apothecia abundant, sub-phellar or shallowly intra-phellodermal; erumpent, gregarious or solitary, often two to several from a common base; *stipes* short to moderately long, up to 1 mm. long, each with one or a few cups; *cups* when young tightly closed, with age opening circularly and expanding under moist conditions to a saucer-like or disc-like shape with an even or undulating, thin margin; usually drying circularly but when large, particularly when overmature, by folding inward in several flaps; externally whitish with cylindrical, thin-walled excipular hairs (FIG. 4, *D*); *hairs* moderately to considerably roughened by minute tubercles, with unswollen or only slightly swollen, gently rounded tips, noticeably septate at intervals of from 10 to 25 μ, 2.5 to 4.5 μ broad, persistent even on the most mature and weathered apothecia, most abundant at the margins (FIG. 3, *C*); *discs* pale to bright orange, small to moderately large, 0.5–3.5 mm. wide, occasionally large, up to 5.5 mm. wide, when overmature the surface often reticulated; *hyphae* of the context variable in width, mostly 2.5–4.0 μ wide, irregularly swollen, much branched. **Asci** cylindrical to cylindric-clavate, with rounded or sub-acute apices, size

range (230) 45.0–72.0 × 3.5–7.0 μ, commonly 51–64 × 4.0–5.5 μ (FIG. 3, *A*). **Ascospores** eight, *arrangement* usually uniseriate, oblique, or oblique with the basal spores vertical, occasionally with a change in the direction of the oblique arrangement or biseriate; enclosing *membrane* rounded or sub-acute, following the contour of the ascus wall at the apex; *shape* usually subfusiform to long-elliptical, extreme range from subfusiform to ovate, usually with one end (the lower when in the ascus) more pointed; *walls* thin; *contents* hyaline, neither distinctly guttulate nor nucleate, continuous when in the ascus and upon germination; *germination* monopolar; *germ tubes* only slightly flexuous, soon branching, indistinctly septate at short (8–15 μ) intervals, 1–2 μ wide; *size* range (580) 4.5–8.5 × 2.0–3.0 μ, commonly 5.0–7.5 × 2.0–3.0 μ, twice seen up to 9.0 μ long and up to 3.5 μ wide (FIG. 3, *A & B*). **Paraphyses** usually exceeding the asci by from 5–15 μ, quite frequently branching near the base, slender; *shape* usually cylindrical or tapering very slightly to the base, occasionally slightly swollen near the tips, tips usually rounded, occasionally sub-acute; *contents* obscurely or noticeably septate, minutely guttulate, *size* range (190) 54.0–92.0 × 1.0–2.5 μ (at the widest point), commonly 60–75 × 1.0–2.0 μ, once seen up to 103.0 μ long and twice seen up to 3.0 μ wide (FIG. 3, *A*).

Imperfect fruiting bodies abundant, conspicuous, developing from light-colored, sub-phellar, erumpent stromata; with age becoming multi-loculate, and the outer wall and overlying bark more or less completely lost. The stromata may be seated at various depths in the bark tissues, particularly if the tissues contain fruiting stages (notably pycnia) of *Cronartium ribicola* (FIG. 4, *A & B*). **Conidiophores** erect, entirely lining the locules; simple or sparsely branched, noticeably septate, hyaline, minutely guttulate; bearing sparsely at the sides and sparsely or profusely at the apices the unicellular, curved, subulate spore-bearing elements (phialides). **Conidia** abstricted from the tips of the phialides, often exuded from the tops of the mature stromata in a whitish to brownish, translucent mass (FIG. 4, *D, c*); *shape* oblong, elliptical, ovate, or spherical, occasionally allantoid; *walls* thin; *contents* hyaline, continuous in the fruiting body and upon germination; *germination* monopolar; *germ tubes* straight, slender, 0.5–1.0 μ wide, unbranched and only occasionally septate after four days; *size* range 1.0–4.0 × 1.0–2.0 μ (FIG. 3, *D & E*).

SPECIMENS EXAMINED

Specimens believed to be the *Dasyscypha* in question, on *Pinus monticola:* R. T. Bingham *117A, 151A, 178, 186, 187, 282, 283,*
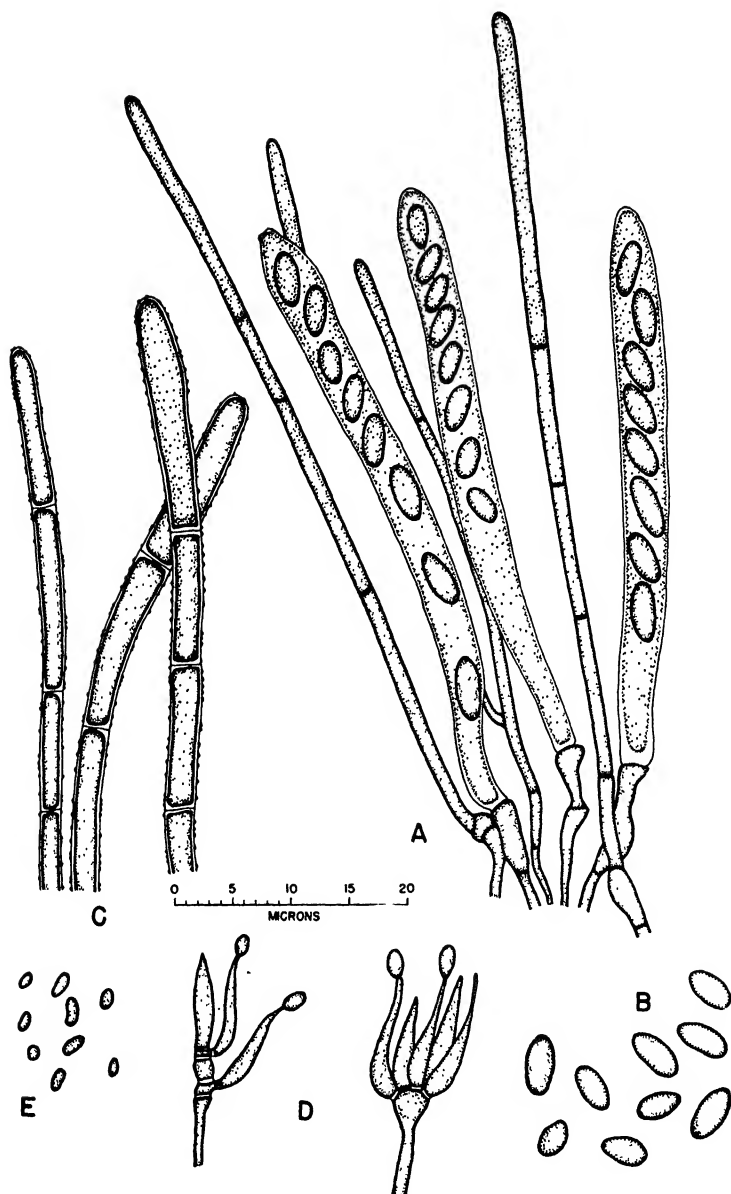
FIG. 3. The *Dasyscypha* on *Pinus monticola*. Drawings made with aid of a micro-projector, from University of Idaho Forest Pathology Herb. *2983*. *A*, asci and ascospores; *B*, ascospores; *C*, excipular hairs; *D*, conidiophores and phialides; *E*, conidia.

284, & 285; C. R. Stillinger *2221* ("*D. Agassizii*"), *2602* ("*D. calyciformis*"), *3490, 3512, 3528, 3574, 3818, 3846, 3895, 3901, & 3908;* J. R. Hansbrough *578 & 579* (NY., "*D. calyciformis*"); University of Idaho Forest Pathology Herb. *1341, 1347* ("*D. calyciformis*"), *1467* ("*D. calyciformis*"); *1966, 2202, 2825, 2826, 2829, 2864, 2983, 2984, 3364, & 3365.*

HOSTS AND GEOGRAPHICAL RANGE

The *Dasyscypha* under consideration seems to occur exclusively on *Pinus monticola*. Although an effort has been made to find this fungus on other hosts in many of the localities where collections have been made it has not, as yet, been found on any of the usual associates of *P. monticola*. In several instances another *Dasyscypha*, close to *D. ciliata* Hahn (**1940**: 141–144), was found on *Abies grandis* (Univ. of Idaho Forest Path. Herb. *2828*).

The geographical range of the fungus on *P. monticola* can be said to cover a large part of the geographical range of its host. Specimens from Oregon, British Columbia, Washington, and Idaho have been examined. Due to the prevalence of *Cronartium ribicola* over the entire geographical range of *P. monticola*, and to the prevalence of the *Dasyscypha* in localities where suitable substrata (notably blister rust cankers) are present, it is presumed

FIG. 4. The *Dasyscypha* on *Pinus monticola*. *A* and *B*. Two parts of the same transverse section through infected bark, showing (*A*) an erumpent, subphellodermal, multi-loculate imperfect fruiting body of the *Dasyscypha* in the bark adjoining a pycnium (*p*) of *Cronartium ribicola*, and (*B*) a shallower, subphellar, multi-loculate imperfect fruiting body directly above the same pycnium (approx. × 100). *C*. Pure cultures in 2½ per cent malt agar slants (approx. × ½). Cultures originated from (*a*) several ascospores, (*b*) a single ascospore, (*c*) bark artificially inoculated with ascospores, (*d*) several conidia produced in culture, (*e*) a single conidium, and (*f*) naturally inoculated bark. All figured cultures had been growing for at least three months, with the exception of (*f*) which had been growing for less than three weeks. The hemispherical mound (*h*) to which the mycelium is often restricted during its early growth can be seen in (*e*). *D*. Habit, on a dead blister rust canker (approx. × 1½): (*a*) moistened, expanded, mature apothecia; (*b*) moistened, but still goblet-shaped, immature apothecia; (*c*) masses of conidia exuded from the imperfect fruiting bodies. *E*. Imperfect fruiting bodies produced on twigs of *P. monticola* protruding above malt-agar slants (approx. × 1): cultures originated from (*a*) bark, (*b* and *c*) several ascospores, and (*d* and *e*) a single conidium. The white nodules on the twigs are multi-loculate imperfect fruiting bodies from many of which conidia are exuding.
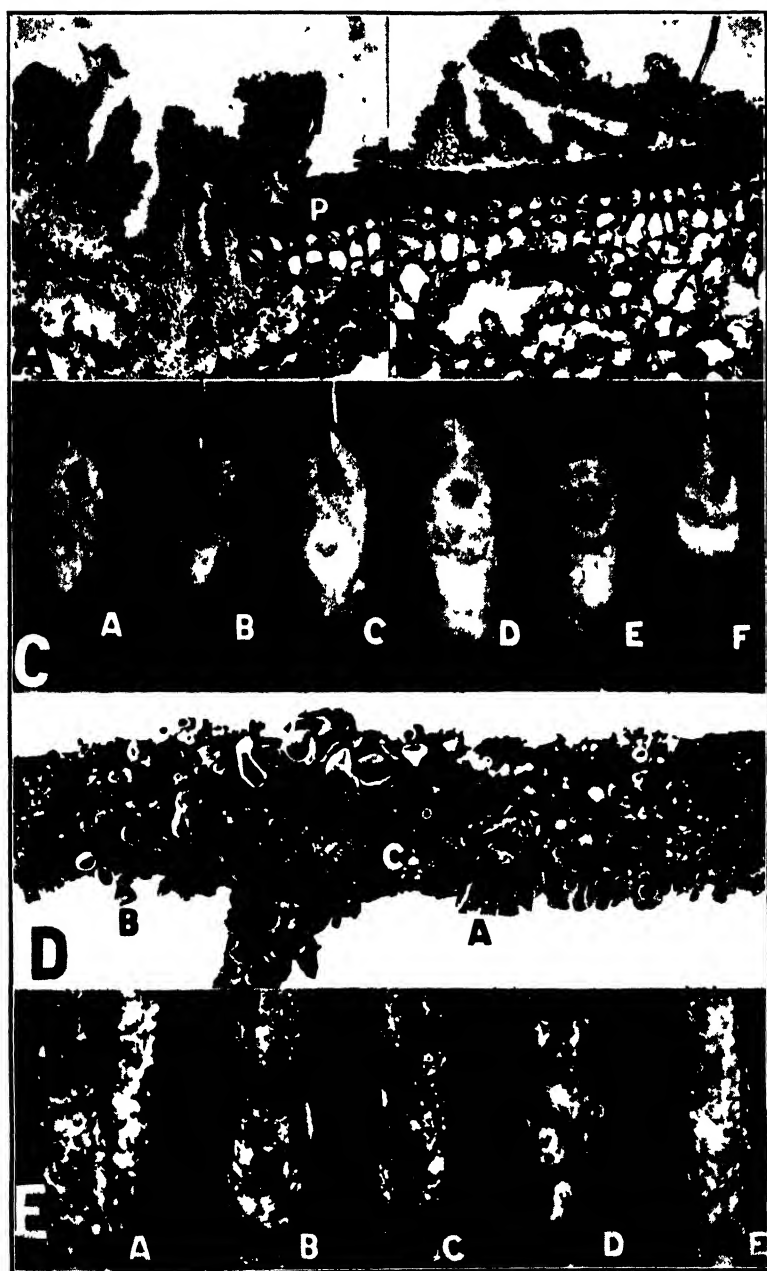
FIG. 4.

that the geographical range of the *Dasyscypha* is actually almost co-extensive with the geographical range of *P. monticola*.

PARASITISM

The *Dasyscypha* under consideration is undoubtedly a weak parasite (one incapable of initiating attack and invading only after the host tissues have been weakened by some other agency) or a saprophyte on *Pinus monticola*. In localities where *C. ribicola* is present it has usually been found on the live and dead blister rust cankers of *P. monticola*, while in localities where the rust is not present it has been found only on dead, wounded, or otherwise infected bark. It is noteworthy that where found as a weak parasite on blister rust cankers, the fungus is of some value as a biological control agent for the blister rust disease. Once established, it kills the bark much more rapidly than does *C. ribicola*, causing the premature death of cankered branches and thus blocking the advance of the rust into the trunk. Even more important, it reduces aecial sporulation of the rust.

DISCUSSION

The *Dasyscypha* on *Pinus monticola* may be distinguished from its close relatives *D. Agassizii* and *D. calyciformis* by its sub-fusiform to long-elliptical ascospores (the ascospores of both *D. Agassizii* and *D. calyciformis* are elliptical to plump-ovate) which are of intermediate length, by its lack of swollen paraphyses tips and flat-topped ascus membranes (characteristic of *D. Agassizii*), by its imperfect stage which is both conspicuous and abundant (not characteristic of either *D. Agassizii* or *D. calyciformis*), and by its restriction to *Pinus monticola* (both *D. Agassizii* and *D. calyciformis* occur on *Pinus* but most frequently on *Abies*; the latter has apparently not been reported on soft pines in Europe). It may be further distinguished from *D. calyciformis* by the ready germinability of its conidia. Plassmann (**1927**: 15–19) and Schellenberg (**1905**: 175) reported that the conidia of *D. calyciformis* could be germinated only infrequently and with great difficulty while the opposite has been found to be true of the *Dasyscypha* in question. Many of the cultures made during this study have, in fact, originated with conidia.

Hahn (**1940**: 138–144) has recently described two similar, new species of *Dasyscypha* on *Pseudotsuga taxifolia* (Lamb.) Britt. in the Pacific Northwest. One of these, *D. ciliata*, is easily distinguished from the *Dasyscypha* on *Pinus monticola* by the large size of the asci (63.0–92.8 × 6.0–12.0 μ) and ascospores (8.0–12.4 × 3.4–5.4 μ). The other, *D. Pseudotsugae*, is less easily distinguished from the *Dasyscypha* on *P. monticola:* the asci (47.0–60.0 × 3.4–5.4 μ) are only slightly smaller and the ascospores (3.8–7.2 × 1.8–3.6 μ) only slightly shorter than those of the *Dasyscypha* in question. However, the ascospores are often distinctly biguttulate and are uniseriately arranged in the ascus and the paraphyses are characteristically unbranched.[1] In addition, the differences in host, in geographical range (west of the Cascades), and in parasitism (apparent ability to induce cankers on a healthy host) should serve to distinguish *D. Pseudotsugae* from the *Dasyscypha* in question.

The conidial fruiting bodies resemble those of *D. calyciformis* and *D. Agassizii*. They are, however, conspicuous and abundant, usually being the only stage present on live blister rust cankers. The perfect stage does not form until the entire canker, or a considerable portion of the canker, has died.

CULTURE NOTES

More than 200 cultures of about 75 different isolates of the *Dasyscypha* on *Pinus monticola* have been under observation during 1940 to 1942. Monoascospore, multi-ascospore, mono-conidium, multi-conidium, and bark cultures grew readily but slowly on 2½-per-cent-malt agar and on potato-dextrose agar. At the end of one month growth in unsealed Petri-dish cultures at room temperature almost ceased, apparently due to drying of the medium. Growth continued up to six months on malt-agar slants kept in a refrigerator at five to ten degrees Centigrade, the mycelium, in several instances, remaining viable for more than a year.

On the 2½-per-cent-malt agar slants the development of all types of isolates was similar (FIG. 4, *C, a–f*). The slow spreading azonate aerial mycelium was at first white, fine, cottony, moder-

[1] Examination of fresh material was made possible through the courtesy of Dr. Hahn and Dr. J. W. Kimmey.

ately dense, in small tufts up to one centimeter high, and often
temporarily restricted to small hemispherical mounds (h), the
vestiges of which were still visible in the older cultures (FIG. 4,
C, e).   The mycelium remained azonate but with increasing age
became cream buff (Ridgway 1912, pl. 30), matted, and dense
with only a few small tufts of the original white, moderately
dense mycelium remaining.   Within fifteen to twenty-five weeks
the mycelium in the malt-agar slants became congested in small,
inconspicuous nodules, or stromata.   The stromata, however, did
not become loculate or produce conidia, the medium in the un-
sealed slants apparently becoming too dry to support further
growth of the culture.   Certain color changes were noted in the
malt agar supporting growth of the fungus: pigmentation was
always present, ranging from tawny at the center of the colony
to orange buff and then to pale orange yellow (ibid., pl. 3, 15) at
the edges of the colony, starting a few weeks after inoculation of
the slant and spreading with enlargement of the central tawny
zone.

Microscopically, the mycelium from all types of isolates was
similar.   Commonly it consisted of long, somewhat flexuous, nar-
row (0.5–1.0 μ) hyphae which were septate and branched with
moderate frequency at acute to right angles.   Occasionally there
were broader (2.0–2.5 μ) hyphae with infrequent, bulbous swell-
ings up to 4.5 μ wide.   Anastomoses were not uncommon.

Mature, multi-loculate imperfect fruiting bodies with viable
conidia developed on *Pinus monticola* twigs which had been added
to the standard 2½-per-cent-malt agar slants before autoclaving.
The mycelium spread rapidly over the lower portion of the twigs
and within as little as 7½ weeks became congested in relatively
large, conspicuous stromata.   Within as little as 14½ weeks ma-
ture, imperfect fruiting bodies formed on the surface of the pine
twigs (FIG. 5, E, a–e).   These superficial bodies exuded conidia
from the locules in large, translucent, yellowish-white tendrils.
They continued to mature and produce conidia until the cultures
dried.   In one twig slant, after forty-four weeks, subphellar or
intra-phellodermal imperfect fruiting bodies were found in the
bark near the tops of the twigs.   Paired twig slants, one with the
usual cotton plug and one with the cotton plug sealed over with
parafilm, were used in each instance.   It was noticed that the

sealed slants produced a greater number of larger and more heavily sporulating imperfect fruiting bodies.   It was noteworthy that sporulating bodies were not produced in the standard malt-agar slants while on twig slants they were produced in every case and within as short a period as $14\frac{1}{2}$ weeks.   Hahn (**1934**: 93), on the other hand, reported the development of sporulating bodies in 3-per-cent-malt agar slants by four different large-spored species of *Dasyscypha*.

Apothecia were not produced in culture.   Observation periods for malt-agar slants were as long as 135 weeks and for twig slants as long as 125 weeks.   Cultures were frequently moved between a dark refrigerator, at a temperature of five to ten degrees Centigrade, to a day- or artificially lighted cabinet, at room temperature.   Neither the changing conditions of light and temperature nor the drying of the medium helped in stimulating perfect-stage fruiting.

SPORE GERMINATION

The germination of ascospores and conidia in water was studied in Van Tieghem cells.   Ascospore germination was observed several times; conidium germination, only once in the hanging-drop cultures, at which time close examination was made difficult by the small size of the conidia and germ-tubes as well as by Brownian movement of the conidia.   Both ascospores and conidia were frequently observed during germination on filtered-agar plates used for making single-spore cultures.

Ascospores germinated three to eight days after sowing.   The germ-tubes were monopolar and narrow (0.5–$1.0\ \mu$ wide); they grew slowly, within a few days developing branches and indistinct septa.   Three to four days after germination the germ-tubes became slightly flexuous and the septa became more distinct. Branching was at no time profuse nor did the germ-tubes ever become more than slightly flexuous.   Ascospores were also observed germinating within the ascus, the germ-tubes soon piercing and protruding from the ascus wall.

Conidia, where once closely examined, were found to germinate within four days by monopolar, very narrow ($0.5\ \mu$ wide), straight germ-tubes.   Some swelling preceded germination.   The germ-tubes, from this stage on, developed much as did the ascospore

germ-tubes, becoming septate, branched, slightly flexuous, and of greater width.

More than two-hundred inoculations were made on *Pinus monticola* during the years 1940 to 1942. The purpose of these inoculations was to ascertain whether the *Dasyscypha* can enter intact bark, to ascertain the points in the development of blister rust cankers at which the *Dasyscypha* gains entrance, and to study the subsequent development of the *Dasyscypha* and its lesion. A system of quadruplicate inoculations was devised, wherein artificially wounded and unwounded blister rust cankers representing two different developmental stages of *C. ribicola* were inoculated with mycelium, ascospores, and conidia.

Unfortunately, the inoculations were almost entirely unsuccessful: only four reisolations, attempted from seven to fifteen weeks after inoculation, were obtained. In many instances small lesions, apparently caused by the inoculated fungus, developed for a short time about the points of inoculation, then ceased development. In the majority of cases these lesions were in blister-rust infected or otherwise wounded bark, particularly when the bark had been inoculated with ascospore or conidium suspensions using a hypodermic syringe and a fine, non-clogging, side-issue needle like that introduced by Ivanoff (**1934**: 74, FIG. 1, *A*) and improved by Dr. L. J. Tyler and Dr. K. G. Parker of Cornell University.

It was believed that exposure of inoculum and infection courts to fluctuating high temperatures and low humidities immediately following a five-day initial incubation period was the main cause of failure. This conclusion is strengthened by the fact that the *Dasyscypha* is most prevalent in the field on moister, shaded sites and is often entirely absent on drier, unprotected sites.

The *Dasyscypha* was frequently found in the field fruiting on sunken necrotic portions of live blister rust cankers. When found on live cankers the imperfect stage usually predominated; on dead cankers the perfect stage was most prevalent. The fungus was isolated repeatedly from the bark at the margins of lesions on live cankers and it was, therefore, presumed to be the probable

cause of these lesions. The lesions had a distinct and slightly raised margin indicating that the causal fungus had incited wound responses. Microscopic examinations of transverse sections cut from the margins of lesions bearing conidial fruiting bodies of the *Dasyscypha* confirmed this conclusion.

The necrotic portions were composed of degenerated cortical and phloem cells in which the protoplasmic contents had disappeared or shrunken and the walls had been distorted or had collapsed. The margins of the lesions were bordered by a wound-phellem, several to many cells thick, produced by an active wound-phellogen in which parenchymatous cortical cells were dividing and being cut off in the plane of the lesion margin. The thick-walled, narrow, corky cells of the wound-phellem were quite similar to the cells of the normal phellem layer produced at the healthy bark surface. At the junction of the bark surface and the lesion margin, in fact, the two phellem layers were indistinguishable except for the fact that the wound phellem was underlain by a more conspicuous and actively dividing phellogen.

The inner margins of older lesions, advancing in the radial direction toward the xylem tissues, were faced along a relatively smooth line by the wound-phellem and active wound-phellogen. In still older lesions the margins had reached the xylem tissues, ceased advancing in the radial direction, and spread tangentially faced by a similar phellem and phellogen.

Mycelium was not plentiful, except at the surfaces of the lesions, and then only at the bases of the erumpent imperfect fruiting bodies. Near these the degenerated cells and intercellular spaces were crowded with fine, branching hyphae but deeper in the bark only occasional, single hyphae were seen crossing cell lumina. No aggregation of hyphae was seen at the inner lesion margins. Hyphae of *Cronartium ribicola* in the dead tissues were relatively scarce, often collapsed, and presumably dead, while immediately behind the actively dividing cells of the wound-phellogen, in the live tissues, the hyphae of *C. ribicola* were abundant.

The formation of wound-phellem varied apparently depending on the rate of advance of the lesion margins. In a few instances lesion margins were seen which were not yet opposed by a definite wound-phellem but which were entirely bordered by an actively dividing wound-phellogen. In other instances, lesion margins

were seen which had advanced over well established wound-phellem layers, accompanied by the formation of new wound-phellogens bordering the area of latest encroachment. These facts seem to indicate that lesion advancement is also variable, possibly greatest at certain seasons when the rate of wound-phellem formation cannot keep pace with the rapidly advancing lesion margins. Langner (**1936**: 145) reported that a corky layer in *Larix* bark was, likewise, unable to prevent advance of *D. Willkommii.* He also reported (*ibid.*: 144) that the hyphae could not penetrate living bark but that their presence in adjoining dead bark so sensitized the living bark that it was frost-killed, allowing their subsequent further spread. This may also be true of the *Dasyscypha* on *Pinus monticola.*

The hyphae of the obligate parasite *Cronartium ribicola* cause no immediate necrosis and incite no cork formation in bark tissues; the hyphae of the facultative parasite *Dasyscypha*, in contrast, apparently cause necrosis and incite wound-cork formation in the bark tissues. Metabolic products of the *Dasyscypha* are thus apparently at once more stimulatory and more toxic than those of the *Cronartium.* Curiously, despite the added resistance of the wound-phellem layer, lesion development is rapid and results in death of the bark tissues in that portion of a blister rust canker which would normally be the first to produce pycnia and aecia of the rust.

DISCUSSION AND CONCLUSIONS

The small-spored, white-excipled *Dasyscypha* on *Pinus monticola* has been compared with *D. Agassizii* and *D. calyciformis*, with both of which it has heretofore been confused. The differences which are now recognized between the three fungi are tabulated below.

The *Dasyscypha* on *Pinus monticola* can thus be readily distinguished from *D. Agassizii*: it has unswollen paraphyses, round-topped ascus membranes, apothecia with relatively short stipes and narrow discs, and an abundant and conspicuous imperfect stage with subulate phialides; *D. Agassizii*, on the other hand, has swollen paraphyses, flat-topped ascus membranes, apothecia with relatively long stipes and broad discs, and an infrequent and inconspicuous imperfect stage with moniliform or slightly subulate

	D. calyciformis	The Dasyscypha on Pinus monticola	D. Agassizii
Apothecia			
No. from a common base	1 or a few	1 or a few	1 to more than 12
Width of discs	0.5–2.0 mm.	0.5–3.5 mm.	0.5–5.5 mm.
Length of stipes	Short	Up to 1 mm.	Up to 2.5 mm.
Excipular hairs	Persistent	Persistent	Lost with age
Asci			
Membrane	Round-topped	Round-topped	Flat-topped
Length	36.0–58.5 μ	45.0–72.0 μ	43.5–67.5 μ
Width	4.0– 6.0 μ	3.5– 7.0 μ	4.0– 6.0 μ
Ascospores			
Shape	Elliptical to plump-ovate	Subfusiform to long-elliptical	Elliptical to plump-ovate
Contents	Indistinctly biguttulate and nucleate	Neither biguttulate nor distinctly nucleate	Indistinctly biguttulate and nucleate
Length	4.0–7.5 μ	4.5–8.5 μ	5.0–9.5 μ
Width	1.5–3.5 μ	2.0–3.0 μ	2.0–4.0 μ
Paraphyses			
Tips	Usually un-swollen	Usually un-swollen	Usually swollen
Length	45.0–77.0 μ	54.0–92.0 μ	47.5–94.5 μ
Width	1.0– 3.0 μ	1.0– 2.5 μ	1.0– 3.5 μ
Imperfect fruiting bodies			
Stromata	Inconspicuous, infrequent	Conspicuous, abundant	Inconspicuous, infrequent
Phialides	Subulate	Subulate	Moniliform or slightly subulate
Exuded spore masses	Not seen	Common	Rare
Germinability of conidia	Inconsistent	Consistent	Not known
Hosts			
	Abies; less commonly *Pinus*, et al.	*Pinus monticola*	*Abies;* less commonly *Pinus*, et al.
Geographical range			
	Europe; N. Zeal.[2]	NW. N. America	NE. N. America

[2] On *Pinus Banksiana* Lamb., *P. Laricio* Poir., *P. ponderosa* Dougl., and *P. radiata* Don. *Vide:* Entrican, Alex T., p. 7, *in* Annual report of the director of forestry for the year ended 31st March, 1942. New Zealand State Forest Service, 20 p. 1942.

phialides.   The *Dasyscypha* on *Pinus monticola* is less readily distinguishable from *D. calyciformis:* it has an abundant and conspicuous imperfect stage with readily germinable conidia; *D. calyciformis*, in contrast, has an infrequent and inconspicuous imperfect stage with conidia which have been induced to germinate only with difficulty.   Hosts and geographical range provide a convenient means for distinction: the *Dasyscypha* in question has been seen only on *Pinus monticola* in northwestern United States and British Columbia; *D. calyciformis* is known principally on *Abies* in Europe; and *D. Agassizii* is known principally on *Abies* in northeastern North America.

In order to test the value of ascospore and ascus measurements as an aid in distinguishing these fungi, means of one-hundred measurements, from five to ten collections of each species, were compared as follows:

	Dasyscypha calyciformis		The *Dasyscypha* on *P. monticola*		*Dasyscypha Agassizii*
	Microns		*Microns*		*Microns*
Ascospore length					
Mean ± S.E.[3]	5.8 ± .078		6.0 ± .092		6.7 ± .088
Difference		0.2		0.7	
S.E. of Diff.		0.12		0.13	
Significance [4]		1:1–5:1		>99:1	
Ascospore width					
Mean ± S.E.	2.4 ± .034		2.4 ± .034		2.9 ± .036
Difference		0.0		0.5	
S.E. of Diff.		—		0.05	
Significance		—		>99:1	
Ascus length					
Mean ± S.E.	49.0 ± .437		57.9 ± .405		55.3 ± .390
Difference		8.9		2.6	
S.E. of Diff.		0.60		0.56	
Significance		>99:1		>99:1	
Ascus width					
Mean ± S.E.	4.5 ± .041		4.7 ± .038		4.8 ± .041
Difference		0.2		0.1	
S.E. of Diff.		0.056		0.056	
Significance		>99:1		20:1–99:1	

[3] Standard error of the mean.

[4] Significance is expressed in odds that the calculated differences between means could not have arisen by chance from samples of a single universe and thus indicate the probability that the contrasted means are in fact significantly different.   The odds shown were obtained by means of the "*t* test."

Although the means of these measurements lie close together, it is evident that such measurements will serve to distinguish the three fungi.   The *Dasyscypha* on *P. monticola* cannot be distinguished from *D. calyciformis* by ascospore measurements but can be readily distinguished on the basis of ascus length.   On the other hand, while it can hardly be distinguished from *D. Agassizii* by ascus measurements, these two fungi can be readily distinguished on the basis of ascospore measurements.   Save for the differences between the means of ascospore measurements for the *Dasyscypha* on *P. monticola* and *D. calyciformis*, the differences between means are all significant.

On the basis of these differences, as well as of others discussed above, the *Dasyscypha* on *P. monticola* appears to be distinct from both *D. calyciformis* and *D. Agassizii*.   Since it has not been possible to compare large numbers of collections on various hosts, both morphologically and culturally, the fungus on *P. monticola* is not proposed as a new species.

SUMMARY

A small-spored, white-excipled *Dasyscypha* frequently found associated with blister rust cankers on *Pinus monticola* in the northwestern United States has, in the past, been confused with *D. Agassizii* and *D. calyciformis*.   Specimens of the three fungi were examined and their morphological features, hosts, geographical ranges, and parasitism were compared.   In addition, cultural and pathological studies of the *Dasyscypha* on *Pinus monticola* were made.

As a result, the fungus is considered distinct from *D. Agassizii* and *D. calyciformis*.   In view of the fact that it was not possible to compare large numbers of collections of the three fungi on various hosts, both morphologically and culturally, the *Dasyscypha* on *Pinus monticola* was not proposed as a new species.

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LITERATURE CITED

Batsch, A. J. G.   Elench. Fung.   Contin. 1: 183 p.   1786.
Berkeley, M. J.   Notices of North American fungi (Continuation).   Grevillea 3: 145–160.   1875.

Bingham, Richard T. & John Ehrlich. A *Dasyscypha* following *Cronartium ribicola* on *Pinus monticola.* I. Mycologia 35: 95–111; *2 fig.* 1943.

Bisby, G. R. The fungi of Manitoba and Saskatchewan. Ottawa: National Research Council of Canada; 189 p. 1938.

Briquet, John. International rules of botanical nomenclature. Jena: G. Fischer; 152 p. 1935.

Dillenius, Johann Jacob. Cat. Pl. Grissa; 240 p. 1718; App. (174 p., *16 pl.*). 1719.

Ehrlich, John. Forest pathology in Nova Scotia. Province of Nova Scotia, Dept. Lands and Forests, Report for **1931**: 36–45; *fig. 1–6.* 1932.

Ewan, Joseph. Isotype versus co-type as designations for duplicate type. Chron. Bot. **7**: 8–9. 1942.

Falck, R. Tannensterben in der Eifel. Forstarchiv **3**: 397–409; *4 fig.* 1927. (*From* Rev. Appl. Myc. **7**: 349–350. 1928.)

Feltgen, Joh. Vorstudien zu einer Pilzflora des Grossherzogthums Luxemburg. 3. Luxemburg; 328 p. 1903.

Ferdinandsen, C. Nye erfaringer om vitigere snyltesvampe i vore skove. Dansk Skovforenings Tidsskrift **1928**: 275. 1928. (*From* Zeitsr Pflanzenk. **41**: 358. 1931.)

Fries, Elias Magnus. Syst. Myc. **2**: 275 p. 1822.

Fuckel, Leopold. Symbolae mycologicae. Beiträge zur Kenntniss der rheinischen Pilze. Jahrb. Nass. Ver. Nat. **23–24**: 1–459; *6 pl.* 1869/70.

Gleditsch, Johann Gottlieb. Methodus fungorum exhibens genera species et varietates, cum charactere differentia specifica, synonymis, solo, loco et observationibus. Berolini; 162 p., *6 pl.* 1753.

Hahn, Glenn Gardner. *Dasyscyphae* on conifers in North America. IV. Two new species on Douglas fir from the Pacific Coast. Mycologia **32**: 137–147; *fig. 1–2.* 1940.

Hahn, Glenn Gardner & Theodore T. Ayers. *Dasyscyphae* on conifers in North America. I. The large-spored, white-excipled species. Mycologia **26**: 73–101; *pl. 8–13.* 1934.

Ivanoff, S. S. A plant inoculator. Phytopathology **24**: 74–76; *fig. 1.* 1934.

Jørstad, Ivar. Norske skogsykdommer. I. Nåletresykdommer bevirket av rustsopper, ascomyceter og fungi imperfecti. Norske Skogforsøksvaesen, Meddelelser **6**: 19–186. (English summary, 156–175.) 1925.

Jørstad, Ivar. Innberetning fra statsmycolog Ivar Jørstad om soppsykdommer på skogtraerne i årene 1926–1930. Norske Skogvaesen, Beretning **1930**: 78–96. 1931.

Karsten, P. A. Revisio monographica atque synopsis Ascomycetorum in Fennia hucusque detectorum. Acta Soc. Fauna Fl. Fenn. **2**[6]: 1–174. 1885.

Langner, W. Untersuchungen über Lärchen-, Apfel- und Buckenkrebs. Phytopath. Zeits. **9**: 111–146; *6 tab., 11 fig.* 1936.

Lanjouw, J. On the standardization of herbarium abbreviations. Chron. Bot. **5**: 142–150. 1939.

Ludwig, F. Dendropathologische Notizen. Forstlich-Naturwiss. Zeits. **3**: 337–338. 1894. (*From* Zeits. Pflanzenk. **6**: 95. 1896.)

Mason, E. W. Annotated account of fungi received at the Imperial Mycological Institute, Kew. List II (Fascicle 3—General Part): 69–99; *fig. 20–30.* 1937.

Maublanc, A. A propos du *Dasyscypha calyciformis* (Willd.). Bull. Soc. Myc. Fr. **20**: 232–235; *fig. 1–8.* 1904.

Noack, M. p. 707, *in* Sorauer, Handbuch der Pflanzenkrankheiten, ed. 6, **II** (1). Berlin: Paul Parey; vii & 758 p. 1928.

Oudemans, C. A. J. A. Enumeratio systematica fungorum. Vol. **I.** Hagae: Martinum Nijhoff; cxxvi & 1230 p. 1919.

Plassmann, Eberhard. Untersuchungen über den Lärchenkrebs. Neudamm: J. Neumann; 88 p., *20 fig.* 1927.

Plassmann, Eberhard. Zum Tannensterben in der Eifel. Zeitschrift für Forst- und Jagdwesen **60**: 272–283; *4 pl.* 1928. (*From* Rev. Appl. Myc. **7**: 686–687. 1928.)

Rehm, H. Ascomyceten: Hysteriaceen und Discomyceten. *In* Rab. Krypt.-Fl., ed. 2. Leipzig: Eduard Kummer. 1 (3): 1275 p.; *fig.* & index 169 p. 1887–1896.

Ridgway, Robert. Color standards and nomenclature. Washington, D. C.: Published by the author; iii & 43 p., 7 *tab.*, *53 pl.* 1912.

Saccardo, P. A. Syll. Fung. **8**: xvi & 1143 p. 1889.

Schellenberg, H. C. Das Absterben der sibirischen Tanne auf dem Adlisberg. Schweizerische Centralanstalt für das Forstlich Versuchwesen. Mitteilungen **8**: 269–287; *pl. 1–2.* 1905.

Schumacher, Christian Friedrich. Enum. Pl. Saell. **2**: 489 p. 1803.

Seymour, Arthur Bliss. Host index of the fungi of North America. Cambridge: Harvard University Press; xiii & 732 p. 1929.

Snell, Walter H. *Dasyscypha Agassizii* on *Pinus Strobus.* Mycologia **21**: 235–242; *pl. 20.* 1929.

Stillinger, C. R. *Dasyscypha fusco-sanguinea* Rehm on western white pine, *Pinus monticola* Dougl. Phytopathology **19**: 575–584; *fig. 1, pl. 12.* 1929.

Strasser, P. Pius. Zweiter Nachtrag zur Pilzflora des Sonntagberges (N. Österreich). Zool.-Bot. Gesell. **52**: 429–437. 1902.

Wagner, G. Beiträge zur Kenntnis der Pflanzenparasiten. Zeits. Pflanzenk. **6**: 321. 1896. (*From* Noack, 1928.)

Willdenow, Carl Ludwig. Fl. Berol. xvi & 439 p., 7 *tab.* 1787.

Wilson, Malcolm. Notes on new or rare British fungi. Trans. Brit. Myc. Soc. **7**: 79–85. 1921. (*From* Bot. Abstr. **10**: 187. 1922.)

Zederbauer, E. Fichtenkrebs. Centralblatt für das Gesamte Forstwesen, Wien **32**: 1. 1906. (*From* Zeits. Pflanzenk. **17**: 120. 1907.)

STUDY OF BAGNISIOPSIS SPECIES ON THE MELASTOMACEAE

JULIAN H. MILLER AND M. GWENDOLYN BURTON

(WITH 23 FIGURES)

This is a group of interesting fungi occurring on living leaves of various genera and species of the Melastomaceae in tropical America. In the revision of the genus by Petrak (5) species parasitizing this family are placed in the section *Eu-bagnisiopsis*, and this paper is confined to a study of that section.

Many published descriptions are to be found rather widely scattered throughout the literature. It has been the purpose of this investigation to bring these together with a key and descriptions. Several names have been reduced to synonymy, and one new description added.

Most of the specimens studied have been collections of Drs. C. E. Chardon, A. S. Muller, R. A. Toro, and Prof. H. H. Whetzel, gathered in many mycological explorations in Central and South America and the West Indies. In addition to these the writers have been most fortunate in being able to see those in the Theissen herbarium at Harvard University.

The writers wish to acknowledge their appreciation for the loan of specimens to Dr. D. H. Linder, Farlow Herbarium, Harvard University, Dr. F. J. Seaver, New York Botanical Garden, Mr. J. A. Stevenson, U. S. D. A. Mycological Collections, Prof. H. H. Whetzel, Cornell University, and to Dr. C. E. Chardon for specimens from his private herbarium.

BAGNISIOPSIS Theiss. & Sydow, Ann. Myc. **13**: 291. 1915.
 Dothidina Theiss. & Sydow, Ann. Myc. **13**: 302. 1915.
 Haplostroma Sydow, Ann. Myc. **14**: 80. 1916.
 Sucinaria Sydow, Ann. Myc. **23**: 363. · 1925.
 Type: *Bagnisiopsis tijucensis* Theiss. & Sydow.

Stroma pulvinate, erumpent-superficial, dothideoid, locules immersed, or rarely with vertices partially free. Asci with paraphysoids, 8-spored. Spores uniseriate, continuous, elliptical to

spherical, hyaline, finally becoming brown. Conidia filiform, hyaline, borne in locules in a superficial stroma.

The species of this genus are all parasitic on leaves. A stroma originating in the mesophyll, proliferates through the lower epidermis, forming a sessile, slightly hemispheric, superficial portion continuous with the hypostroma. Then flask-shaped spermagonia, partially free, appear on this stroma. These have been filled with spermatea, and at the same time below in the center of the stroma, there are very delicate hyphae surrounding portions of a larger, deeply staining thread, which is probably the archicarp. Then, later stages of the stroma (FIG. 11) were found with spermagonia above and young locules containing ascal initials. This phase was not investigated further because of the lack of fresh material.

The conidia are borne in a superficial stroma resembling that of the ascigerous stage, and occasionally both are found in the same stroma. This asexual stage falls within the form genus *Hemidothis*. Sydow (10) erected it with the single species *Miconiae*, on *Miconia* sp., and Petrak (4, 6) showed the connection with *Bagnisiopsis*.

The mature ascal stroma in *Bagnisiopsis* has no characteristic shape, varying from a regular cupulate disc to an irregular pulvinate mass, and from containing single locules to many, all on the same leaf. Also, the dimensions of the ascospores are more variable than in most Ascomycetes previously studied by the writers. These facts probably account for the many species in the literature.

In this section of *Bagnisiopsis* there does not seem to be any limitation of species to either genera or species of the Melastomaceae.

Theissen and Sydow (11) created *Bagnisiopsis* to include hyaline spored forms with locules in a dothiodeoid stroma, with paraphyses, and at the same time erected *Dothidina* for similar forms with colored spores. Later Petrak (5) discovered that the ascospores of the type of the former finally become brown and merged the two genera.

The genus *Sucinaria* was placed in the Hypocreales by its author, Sydow (8), with all of the characters of *Bagnisiopsis*

except the fleshy, light colored stroma. The centrum characters, as well as most of those of the stroma, are typical of the *Bagnisiopsis* group with surface projections, and the light colored stroma is not sufficient to place it in a separate order. Petrak (5) recognized this relationship with *Bagnisiopsis* by pointing out that both groups grow on the same hosts and both are parasitized by *Protoscypha pulla* Sydow. Clements and Shear (3) place *Sucinaria* in the Hypocreales, but the writers see no distinction from *Bagnisiopsis* and reduce it to synonymy.

Petrak (5) divides *Bagnisiopsis* into three sections as follows:

1. Section *Eubagnisiopsis*. This includes typical forms growing on the Melastomaceae. Stromal tissue chiefly thread-like, often only the outer crust plainly cellular, rather fleshy, gelatinous or cartilaginous-fleshy, more or less bright colored inside and surrounded by a thin, dark colored layer. Spores somewhat small and usually not over 20 μ in length.

2. Section *Phoenicostroma* (Sydow) Petrak. The species that belong here grow on palm leaves, and are characterized by the lower part of the stroma strongly developed, more or less prosenchymatous, entirely opaque-black or dark brown, brittle carbonous. Spores usually over 20 μ long.

3. Section *Chaetobagnisiopsis* Petrak. These forms are separated by the presence of setae either only on the edge of the stroma or irregularly scattered over the surface. Spores apparently remaining hyaline.

The stromal characters of the species in the section *Phoenicostroma* are so distinct from those on the Melastomaceae that it seems best to continue the group as a genus distinct from *Bagnisiopsis*.

Petrak's other section, *Chaetobagnisiopsis*, contains only two species, *B. polymorpha* (Stevens) Petrak, and *B. nuda* (Stevens) Petrak. He thinks their relationships lie with *Bagnisiopsis*, but as they do not occur on the Melastomaceae they are not included in this study.

Theissen and Sydow (11), as well as Clements and Shear (3), place *Bagnisiopsis* in the Dothideales, but Petrak (4, 5) concludes that the genus is closely related to *Phyllachora* through the type of ascospores and conidia, and differs only in the stroma

being superficial, and that both belong in the Sphaeriales.   The
writers, however, think the absence of a special wall to the locules
(FIG. 9) and the presence of paraphysoids, definitely separate it
from *Phyllachora* and place it in the Pseudosphaeriales.

Bagnisiopsis is distinct from the Dothideales in possessing a
wall layer of asci, rather than the fascicle, and in the filiform
threads between the asci.

The relationships of *Bagnisiopsis* are with such genera as
Botryosphaeria, Physalospora, Cucurbitaria, Pleospora and others.
It is separated from the most closely related genus, *Botryo-
sphaeria*, by filiform conidia, asci not thickened at the tips, and
the finally superficial stroma.

<div align="center">KEY TO THE SPECIES OF SECTION <i>Eubagnisiopsis</i></div>

Stroma black, coriaceous
    Stroma without seta-like processes
        Ascospores elliptical

Spores 8–15 × 4–7 μ	1. *B. Leandrae*
Spores 11.4–17 × 7.6–12 μ	2. *B. tijucensis*
Spores 13.3–24 × 7.6–12 μ	3. *B. peribebuyensis*

        Ascospores sphaerical

Spores 7.6–11.4 μ	4. *B. sphaerospora*

    Stroma with such processes

Spores 7.6–16 × 7.6–11.4 μ	5. *B. Toledoi*
Spores 11.4–22.8 × 7.6–11.4 μ	6. *B. amadelpha*

Stroma translucent, pale brown, fleshy with processes

Spores 8–10 × 6.5–7.5 μ	7. *B. minuta*
Spores 11.4–19 × 7.6–9.5 μ	8. *B. translucens*

1. **Bagnisiopsis Leandrae** (Sydow) comb. nov.
    Auerswaldia Leandrae Sydow, Hedwigia **40**: 2.   1901.
    Auerswaldia Miconiae P. Henn. Hedwigia **43**: 253.   1904.
    Rosellinia Miconiae (P. Henn.) Hohnel, Sitz-ber. Akad. Wien.
        118[1]: 828.   1909.
    Dothidina Leandrae Sydow, Ann. Myc. **13**: 302.   1915.
    Dothidina Miconiae (P. Henn.) Theiss. & Sydow, Ann. Myc.
        13: 303.   1915.
    Bagnisiopsis minutula Petrak, Hedwigia **68**: 278.   1928.
    Type: Material on *Leandra cordifolia*, leg. Reineck, Rio Grande
do Sul, Brazil, 1897, at Harvard herb.

Stromata hypophyllous, in poorly defined spots, closely ag-
gregated or coalesced, in groups or widely scattered, erumpent-
superficial, pulvinate-irregular or disciform, cupulate or appla-
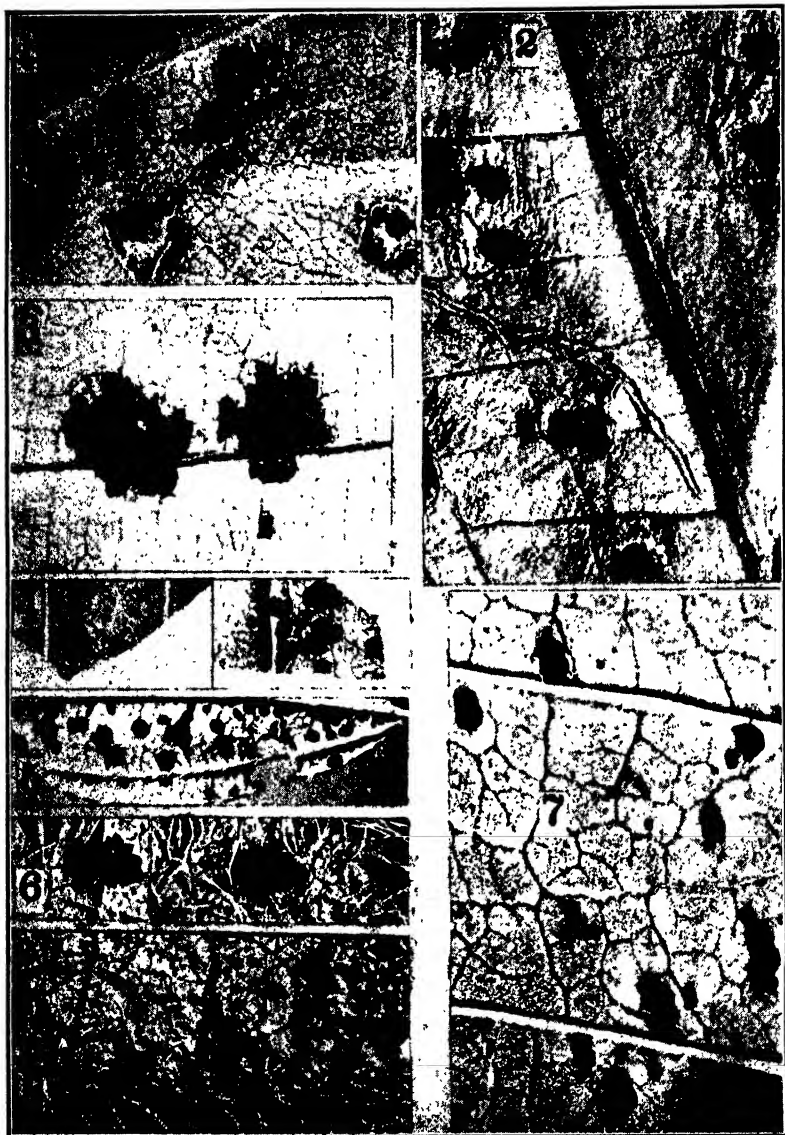
Figs. 1–4. *Bagnisiopsis peribebuyensis*. Enlargements of stromata. 1, Balansa no. *3479*, × 8; 2, Chardon no. *1055*, × 8; 3, Muller no. *508*, × 8; 4, Balansa no. *3894*, type, × 2; 5, *B. tijucensis*, Rehm Ascom. no. *1542*, type, × 2; 6, *B. sphaerospora*, Toro no. *314*, type × 12; 7, *B. amadelpha*, Chardon and Nolla no. *443*, × 12; 8, *B. translucens*, Whetzel and Muller no. *3010*, type, × 12.

nate, slightly constricted at the base, .3–.8 mm. in diam., passing
into the hypostroma, with surface black, even or irregular; locules
one to many, sunken in the stroma, rarely projecting, globose to
angular from mutual pressure, with no special wall, 150–240 μ in
diam., with conical ostiole, immersed; asci cylindrical with uni-
form walls, p. sp. 60–86 $\times$ 7–11 μ, with attenuated stipe 60–90 μ
in length; ascospores continuous, narrowly elliptical to broadly
ovate, rounded at ends, with uniform epispore, .5 μ thick, hyaline
becoming yellowish-brown, 8–15 $\times$ 4–7 μ; paraphysoids numer-
ous, filiform.

Conidia in cavities in stromata, hyaline, filiform, 15–24 $\times$ 1.2 μ.

Hosts: *Leandra cordifolia, Miconia* sp. (*Miconia Pilgeriana* sec.
Ule).

Distribution: Brazil.

This species is distinguished from *B. tijucensis* chiefly through
the possession of smaller spores. The same variations in shapes
of the stroma are found in both.

Petrak (**5**) has this species under *B. minutula.* He changes the
Henning's name *Miconiae* to *minutula* because of the earlier
Sphaeria Miconiae Duby. Then he places *D. Leandrae* under
B. Sellowii as a synonym. However, he saw only specimens
determined as *D. Leandrae* by Sydow, and they were either sterile
or immature.

The spores of *B. minutula* are given by Petrak (**5**) as 8–12
$\times$ 5.5–7 μ; while Theissen and Sydow, under *D. Miconiae,* have
them 11–13 $\times$ 6–7 μ. The latter give those of *D. Leandrae* as
13–16 $\times$ 4–6 μ. The writers find them 10–15 $\times$ 4–6 μ in the
type of *D. Leandrae* and 8–15 $\times$ 5–7 μ in type of *D. Miconiae.*
The spores are slightly narrower in the former, but this difference
is not significant when one considers the great variation in spore
measurements in *Bagnisiopsis.*

MATERIAL EXAMINED

Brazil: On *Leandra cordifolia,* sub *Auerswaldia Leandrae*
Sydow: Rio Grande do Sul, 1897, leg. Reineck, Type; Sao Fran-
cisco, June 1885, Ule *422*: On *Miconia* sp., Sub *A. Miconiae* P.
Henn., Amazonas, Rio Jurua, Aug. 1901, Ule *27*, Appen. Mycoth.
Brazil; duplicate, Ule, Mus. Bot. Berol, Type. Theissen herb.
at Harvard.

2. BAGNISIOPSIS TIJUCENSIS Theiss. & Sydow, Ann. Myc. **13**: 291. 1915.

   ? *Phyllachora gibbosa* Wint. Rev. Myc. **7**: 207.   1885.

   ? *Phyllachora Sellowii* P. Henn. Engl. Bot. Jahrb. **17**: 525. 1893.

   Phyllachora peribebuyensis Speg. var. bullosa Rehm, Hedwigia **35**: 368.   1897.

   Haplostroma depressum Sydow, Ann. Myc. **14**: 80.   1916.

   Bagnisiopsis depressa Sydow, ap. Theissen.   Ann. Myc. **14**: 435.   1916.

   Bagnisiopsis Sellowii (P. Henn.) Petrak, Hedwigia **68**: 269. 1928.

   Bagnisiopsis gibbosa (Wint.) Petrak, Hedwigia **68**: 271. 1928.

   Bagnisiopsis bullosa (Rehm) Petrak, Hedwigia **68**: 283. 1928.

   Bagnisiopsis lata Sydow, Ann. Myc. **28**: 109.   1930.

   Dothidina Parisi Chardon, Myc. Explor. Ven., Monogr. Univ. of Puerto Rico, ser. B. **2**: 139.   1934.

Type: Rehm Ascom. *1542*, in Theissen herb. at Harvard.

Stromata hypophyllous, isolated or in groups, separated or coalesced, in small irregular yellow to dark brown spots visible from both sides of the leaf, erumpent and at maturity superficial but connected with a hypostroma in the mesophyll, black, varying in shape from orbicular and concave with a definite border to hemispherical or even conical, .3–1.5 mm. in diam., and .3–.5 mm. high; surface entire to very irregular, smooth to verrucose; locules one to many, completely immersed, rarely projecting, with no special wall, 250–300 μ in diam., with conical ostioles rarely visible on the surface; asci cylindrical with long attenuated stalks, p. sp. 76–125 × 9.5–13 μ and stalk 75–100 μ in length; ascospores 8, uniseriate or obliquely so, continuous, hyaline to brown with age, broadly elliptical with rounded ends or almost spherical, 11.4–17 × 7.6–12 μ, chiefly 15 × 9 μ, occasionally up to 19 μ in length; paraphysoids filiform, somewhat branched, numerous, persistent.

Conidia borne in cavities in pulvinate stromata resembling those bearing asci, filiform, hyaline, curved, 15–27 × 1–1.2 μ.

Hosts: *Blakea* sp., *Miconia flammea*, *M. lepidota*, *M. marcophylla*, *M. ulmarioides*, *Miconia* sp., *Tibouchina longifolia*, *T. multiceps*, *T. paniculata*, *Tibouchina* sp., Melastomaceae.

Distribution: Brazil, Colombia, Dominican Republic, and Venezuela.

The stromata in the type are fairly smooth, and vary from concave to flat to spherical (FIG. 5). Some are very small containing only one locule, while others are large with from 5 to 10 or even more. No characters have been discovered in this species that will separate it from *B. peribebuyensis* except the smaller and proportionately broader spores. Many of the latter in the type are almost globose.

Theissen and Sydow (11) give spore dimensions as 13–16 × 6–8 μ and Petrak (5) 11–17.5 × 6–8 μ, but the writers find the mature ones of the type much wider, many up to 12 μ in width.

Phyllachora gibbosa, *P. Sellowii*, and *P. peribebuyensis* var. *bullosa* are listed by Theissen and Sydow (11) as synonyms under *B. peribebuyensis*. Petrak (5) on the other hand has these names in his monograph as three separate species.

The Winter type of *P. gibbosa* was not studied, but the specimens, Ule *230* and *681*, and Puttemans *174* cited below, are identified as that species by Petrak, and they are fully equal to the type of *B. tijucensis*.

There are two packets in the Theissen herbarium, nos. *665* and *666*, both determined as *P. gibbosa* by Rehm, and on both is written by Theissen, equals *B. peribebuyensis*. The no. *665* is a mixture of various Melastomaceae leaves and most of them are infected with *B. peribebuyensis*, while no. *666* is certainly *B. tijucensis*. The writers then, chiefly on Petrak's description, place this name under *B. tijucensis* with a question mark.

Phyllachora Sellowii is also placed here with some hesitation. The type has been studied, but the spores are very immature and plasmolized, and are about 12–18 × 7–9 μ, and if further advanced could very well be either *B. tijucensis* or *B. peribebuyensis*. Petrak (5) cites the spores as 10–14 × 4.5–7 μ, which are much smaller than the writers' measurements.

The name *P. peribebuyensis* var. *bullosa* is based on Ule *1848*. Petrak (5) raises the variety to specific rank with spores 11–17 × 6–8 μ. This seems fully equal to the type of *B. tijucensis*.

Sydow describes *B. lata* with spores 11–15 × 8–12 μ and *B. depressa* with ones 14–16 × 8–10 μ, which come within the concept of *B. tijucensis*.   Also, *D. Parisi* has spores within this range. None of these have distinctive characters of the stroma.

MATERIAL EXAMINED

Brazil.   On *Tibouchina* sp., Rehm Ascom. *1542*, sub. *B. tijucensis*, Rio de Janeiro, June 11, 1902, *P. Dusen*, Type; Puttemans *174* sub *B. tijucensis*, Sao Paulo, Mar. 29, 1901; on *T. multiceps*, E. Ule *230*, sub *B. peribebuyensis*, San Francisco, Dec. 1883; on *T. paniculata*, Ule *681*, sub *B. tijucensis*, Rio de Janeiro, Aug. 1887.   Theissen herb. at Harvard.

On *Miconia* sp., Ule *1848*, sub *Phyllachora peribebuyensis* = *B. peribebuyensis* var. *bullosa* Rehm, Ouro Preto, Jan. 1892; on *Miconia flammea*, Ule *180*, sub. *B. tijucensis*, San Francisco; on *Miconia lepidota*, Sellow, Berol. herb., sub *P. Sellowii*, on Melastomaceae, Theiss. *666*, sub. *B. gibbosa*, Sao Leopoldo, 1908, det. Rehm.   Theissen herb. at Harvard.

Colombia.   On *Miconia macrophylla*, Chardon & Nolla *195*. sub *Dothidina scabrosa*, Barro Colorado Isl., Apr. 29, 1929. Cornell herb.

On *Tibouchina longifolia*, Toro *264*, sub *B. tijucensis*, Guarnes, Nov. 3, 1927, and Toro *256*, sub *B. tijucensis*, Titirihi, Aug. 8, 1927.   Chardon herb.

Dominican Republic.   On *Miconia* sp., Chardon *873*, sub *B. peribebuyensis*, Puerto Plata, July 11, 1937.   Cornell herb.

Venezuela.   On *Blakea* sp., Sydow Fungi Ven. *349*, sub *B. lata*, Colonia Tovar, Aragua, Jan. 19, 1928, Type.   Harvard herb. and U. S. D. A. Myc. Coll.

On *Miconia ulmarioides*, R. Alamo *147*, sub *Dothidina Parisi*, El Cedral nr. Los Teques, Miranda, Jan. 7, 1932; Chardon, Toro & Alamo *305*, sub *D. Parisi*, El Cedral, June 26, 1932; Chardon & Toro *532*, sub *D. Parisi*, Miranda, July 11, 1932, Type; Chardon & Guiscafré *578*, sub *D. Parisi*, Knoop's Park, Los Teques, July 13, 1932; Muller 1900, sub *B. tijucensis*, Petare, May 14, 1937; above in Cornell herb. Chardon *2528*, sub *D. Parisi*, Miranda, Apr. 3, 1938, Chardon herb.   F. Tamayo *3897*, sub *Bagnisiopsis* sp., Sebastopol, Miranda, Mar. 1, 1940.   Cornell herb.

On *Miconia* sp. Whetzel & Muller *2843*, sub *B. tijucensis*,
Tucupe near Caracas, Feb. 28, 1939; Whetzel, Muller & Tamayo
3034, sub *B. tijucensis*, Caracas a Colonia Tovar, Mar. 19, 1939;
Chardon *3141*, sub *B. tijucensis*, Aragua, Mar. 25, 1939; Whetzel
& Chardon *3179*, sub *B. tijucensis*, Aragua, Mar. 26, 1939;
Whetzel, Muller & Chardon *3207*, sub *B. tijucensis*, Aragua, Mar.
29, 1939; Tamayo *3447*, sub *B. tijucensis*, Miranda, Apr. 19, 1937;
above in Cornell herb.

3. BAGNISIOPSIS PERIBEBUYENSIS (Speg.) Theiss. & Sydow, Ann.
    Myc. **13**: 292. 1915.

  Phyllachora peribebuyensis Speg. Anal. Soc. Ci. Argent. **19**:
    244. 1886.

  Auerswaldia Fiebrigii P. Henn. Hedwigia **43**: 148. 1904.

  Dothidina Fiebrigii (P. Henn.) Theiss. & Sydow, Ann. Myc.
    13: 303. 1915.

  Dothidina peribebuyensis (Speg.) Chardon, Mycologia **13**:
    289. 1921.

  Dothidina scabrosa Sydow, Ann. Myc. **23**: 384. 1925.

  Bagnisiopsis scabrosa (Sydow) Petrak, Hedwigia **68**: 281.
    1928.

  Bagnisiopsis tovarensis Sydow, Ann. Myc. **28**: 111. 1930.

  Hemidothis Pittierii Sydow, Ann. Myc. **28**: 193. 1930.

Type: B. Balansa *3894*. Part is in Speg. herb. and part in
Theissen herb. at Harvard.

Stromata hypophyllous, isolated or in small groups, compacted
or coalesced, in orbicular discolored spots surrounding the group
or separate under each stroma, with hypostroma in mesophyll,
erumpent, and superficial at maturity, very variable in form,
orbicular with applanate surface, with raised border or not, or
almost globose, smooth, or roughened and scabrous, .2–1.5 mm.
in diam., and .2–.4 mm. high, black, hard-leathery when dry and
almost gelatinous when wet; locules globose to slightly elongate,
250–340 μ in diam., one to many in stroma, immersed, rarely
projecting, with conical ostioles rarely apparent on surface of
stroma; asci cylindrical, stalked, 100–133 × 12–19 μ p. sp., with
stipe 70–95 μ in length, and much attenuated; ascospores 8, uni-
seriate or obliquely so, continuous, hyaline, finally brown, broadly
elliptical with obtuse ends, 13.3–24 × 7.6–12 μ, chiefly 19 × 10 μ
at maturity, with epispore uniform, .5 μ wide; paraphysoids fili-
form, somewhat branched, persistent.
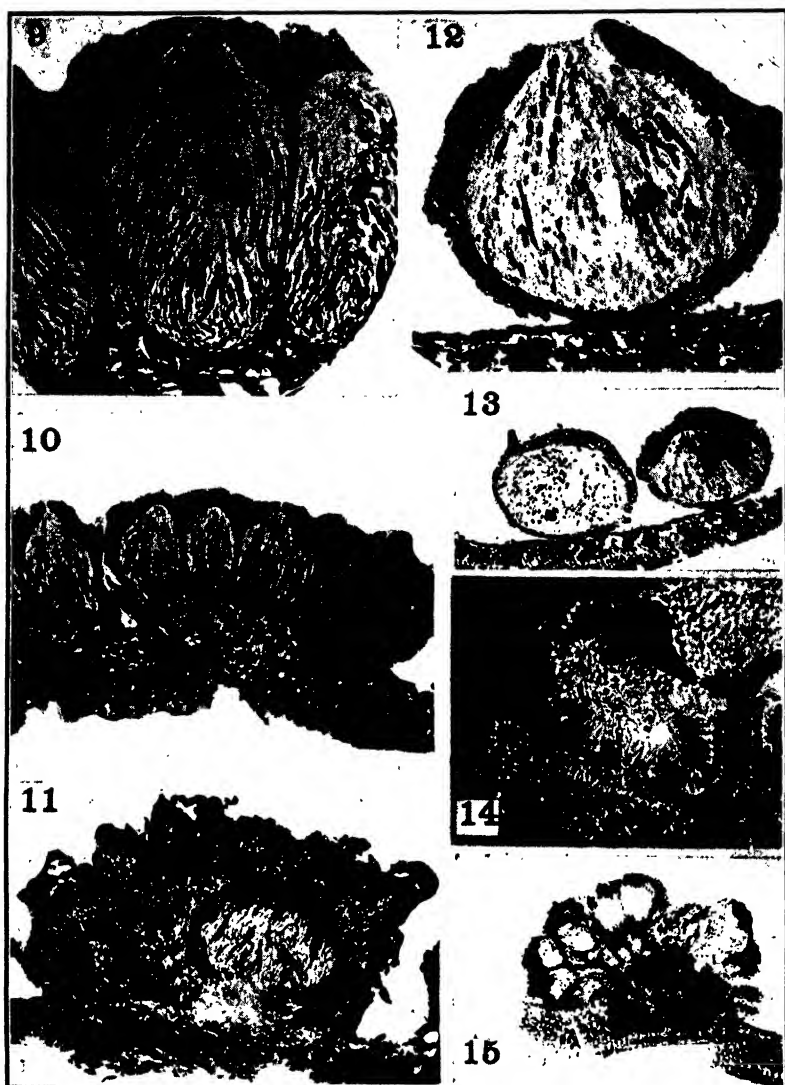
FIGS. 9–15. Photomicrographs of longitudinal sections of *Bagnisiopsis* stromata. 9, *B. tijucensis*, Muller no. *1900*, showing locule with paraphysoids and no special wall, × 263; 10, same section showing the compound stroma of *Bagnisiopsis*, × 83; 11, *B. Toledoi*, Whetzel and Muller no. *2841*, showing young locule and spermagonia on surface of stroma, × 242; 12–13, *B. amadelpha*, Chardon no. *2642;* 12, showing single locule stroma, × 222; 13, showing seta-like process on left side of stroma, × 83; 14–15, *B. peribebuyensis*, Chardon no. *1055*, showing sections through conidial stroma; 14, single cavity with spores, × 263; 15, section of entire conidial stroma, × 45.

Hosts: *Miconia ambigua, M. argentea, M. Beurlingii, M. Candolleana, M. laevigata, M. prasina, Miconia* sp., *Monochaetum hirtum, Tetrazygia elaeagnoides,* and other unidentified Melastomaceae.

Distribution: Brazil, Costa Rica, Dominican Republic, Guatemala, Panama, Paraguay, Puerto Rico, and Venezuela.

The stromata in the type are circular, smooth and applanate, to slightly concave, with several locules and spores chiefly 19 × 10 μ. In looking over the mass of material cited below there are leaves with exactly the same shape stromata as on the small piece of the type (FIG. 4) and often on the same leaf there will be every other shape described for the genus. In fact there does not seem to be any form of stroma constant enough to describe for either this species or *B. tijucensis.* Even when there is only a single locule it is never in the form of a symmetrical flasked-shaped perithecium.

Theissen and Sydow (11) give spores of *B. peribebuyensis* as 11–15.5 × 8–10 μ, Saccardo (7) as 15–18 × 6–8 μ and Petrak (5) as 14–20 × 6–9 μ. Chardon (2) examined the Spegazzini type and finds the spores much larger, 18–24.5 × 9–11 μ. This is approximately the same as measurements of the writers for mature spores. Chardon (1) also noticed that some of the spores in the type were brown and placed this species in *Dothidina.*

The conidia are filiform, hyaline, curved, 15–26 × 1–1.2 μ, borne in labrinthiform cavities of a stroma similar in all respects to that of the ascigerous stage.

Sydow (9) describes *Hemidothis Pittierii* on *Miconia ambigua* as the conidial stage of *B. tijucensis.* His Ascomycete specimen, *163,* that he named with the *Hemidothis* has been studied by the writers and they find large spores typical of *B. peribebuyensis.* Sydow's conidial name then belongs with the latter species.

Sydow (10) earlier describes a *Hemidothis Miconiae* on an unidentified *Miconia* species. It would be impossible to connect this name with any *Bagnisiopsis* species as the description would include any of the conidial stages of this genus.

Petrak (5) places *D. Fiebrigii* under *B. peribebuyensis* as in this paper. The stromata in the type are applanate-orbicular and the spores are approximately the same as in the type of *B. peribebuyensis.*
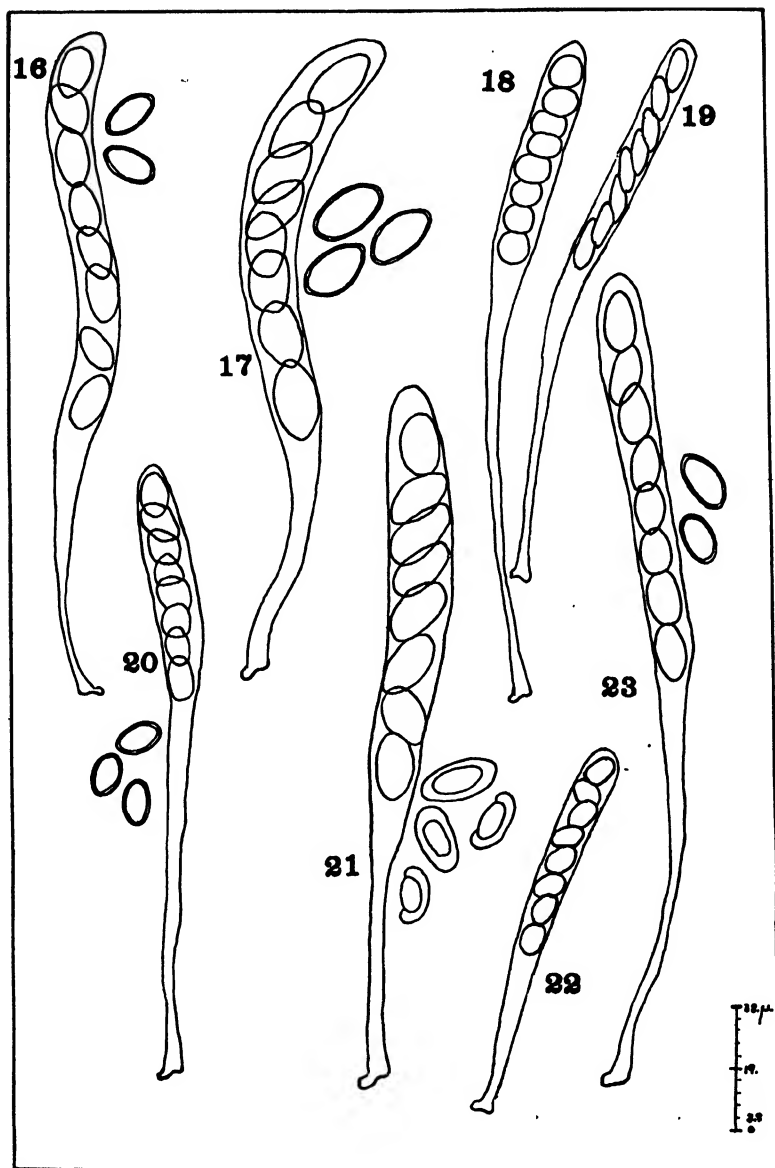
FIGS. 16–22. Camera lucida drawings of asci and ascospores of *Bagnisiopsis*, × 789. 16, *B. tijucensis*, Rehm Ascom. no. *1542*, type; 17, *B. peribebuyensis*, Balansa no. *3894*, type; 18, *B. sphaerospora*, Toro no. *314*, type; 19, *B. Leandrae*, Reineck spec. type; 20, *B. Toledoi*, Chardon and Guiscafre no. *565*, type; 21, *B. amadelpha*, Chardon and Nolla no. *443;* 22, *B. minuta*, Sydow no. *272*, type; 23, *B. translucens*, Whetzel and Muller no. *3010*, type.

The Sydow specimen *147*, cited below sub *Dothidina Fiebrigii*, has been studied and the Harvard packet contains only immature stromata barely erumpent.

The type of *D. scabrosa* consists of very small stromata in compact groups in the thick white hairs of *Miconia argentea*. They appear distinctive, but there are similar groups on smooth *Miconia* leaves that fall within the concept of *B. peribebuyensis*.

The other Sydow name placed here, *B. tovarensis*, according to his *833*, has the large spores of this species.

MATERIAL EXAMINED

Brazil.   On Melastomaceae, B. Balansa *3894*, sub *Phyllachora peribebuyensis*, Peribebuy, Type, Theissen herb. at Harvard; Balansa *3479*, sub *P. peribebuyensis*, Peribebuy, Chardon herb.; Theissen *665*, sub *P. gibbosa*, Rio de Janeiro, Sept. 1908, det. as *B. peribebuyensis* by Theiss. & Syd., Harvard herb.; on *Miconia Candolleana*, E. Ule *1297*, sub *B. peribebuyensis*, Feb. 1888, Theissen herb. at Harvard; Muller *508*, sub *B. tijucensis*, Minas Geraes, April 29, 1933, Cornell herb.; Muller *606*, sub *D. Parisi*, Minas Geraes, June 8, 1933, Chardon herb.: on *Miconia* sp., Ule *2050*, sub *B. peribebuyensis* var. *bullosa*, Tijuca, Apr. 1893, Theiss. herb. at Harvard; Maublanc *844*, sub *B. peribebuyensis*, Minas Geraes, June 9, 1913, Chardon herb.

Costa Rica.   On *Miconia argentea*, Sydow, Fungi Exot. Exsicc. *672*, sub *D. scabrosa*, Alajuela, Oct. 1, 1925, N. Y. B. G. herb.; On *Miconia Beurlingii*, Sydow *147*, sub *D. Fiebrigii*, Feb. 3, 1925, Harvard herb.

Dominican Republic.   On *Miconia prasina*, sub *B. peribebuyensis*, Chardon *554*, Trujillo, June 20, 1937; 707, Samana, July 5, 1937; *1055*, La Vega, Aug. 13, 1937; Cornell herb.

Guatemala.   On *Miconia argentea*, W. A. Kellerman *6102*, sub *D. scabrosa*, between Patwlal and San Lucas, June 26, 1907, Chardon herb.

Panama.   On *Miconia* sp., F. L. Stevens, sub *B. peribebuyensis*, *1072* and *1096*, Tamboa, Aug. 16, 1923; *1317*, Chargres, Aug. 23, 1923; *1326*, France Field, Aug. 24, 1923; *1347*, Gatun, Aug. 24, 1923; Harvard herb.

Paraguay.   On Melastomaceae, Balansa *3854*, sub *P. peribebuyensis*, Carapegua, June 24, 1883, det. Speg.; C. Roum. Fung. Gall. Exsicc. *3242*; Chardon herb.: on *Miconia* sp., sub *Auerswaldia Fiebrigii* P. Henn., Type, Theissen herb. at Harvard.

Puerto Rico.   On *Miconia* sp., Stevens *840*, sub *D. peribebuyensis*, Consumo, Nov. 27, 1913; Whetzel, Kern & Toro, sub *D. peribebuyensis*, *2505*, on *Miconia laevigata*, Yanco, Finca Maria, June 17, 1924; *2491*, on *Miconia prasina*, Guaynabo, June 11, 1924, and *2602*, Guaynabo, July 3, 1924, N. Y. B. G. and Cornell herbs.

On *Tetrazygia elaeagnoides*, Whetzel, Kern & Toro *2579*, sub *D. peribebuyensis*, Vega Beja, June 27, 1924, N. Y. B. G. herb. and Cornell herb.

Venezuela.   On *Miconia ambigua*, Sydow *163*, sub *B. tijucensis* Les Varanjis, Jan. 3, 1928, Harvard herb.

On *Monochaetum hirtum*, Sydow *833*, sub *B. tovarensis*, Colonia Tovar, Aragua, Nov. 1, 1928, Type, Harvard and N. Y. B. G. herbs.

4. Bagnisiopsis sphaerospora (Chardon) comb. nov.

>   *Dothidina sphaerospora* Chardon, Jour. Dept. Agri. Puerto Rico **13**: 7.   1929.

Type: Toro *314*, Chardon herb.

Stromata hypophyllous, chiefly in coalesced glomerules, 2–3 mm. in diam., with single stromata .2–1 mm. in diam., in indistinct spots, black, cupulate with depressed centers or convex, or flattened hemispherical, erumpent then superficial; locules globose or irregular through lateral pressure, 300–400 $\times$ 250–300 μ, with no special wall; asci cylindrical, p. sp. 50–76 $\times$ 10–12 μ with attenuated stipes, 76–125 μ in length; spores 8, uniseriate, continuous, globose, or nearly so, 7.6–11.4 μ in diam., chiefly 8.93 $\times$ 8.17 μ, hyaline, later light brown, with epispore .5 μ thick; paraphysoids numerous, filiform.

No conidia were found in this specimen.

Hosts: *Clidemia impetiolaris*.

Distribution: Known only from the type locality in Colombia.

This species is near *B. tijucensis*, but differs from this and the other species in having most of the spores globose.   The compact masses of stromata are typical of this one specimen, but it is

probable that the distribution would be more variable if many collections were studied.

The transfer to *Bagnisiopsis* is made because *Dothidina* has previously been shown to be synonymous.

Colombia.   On *Clidemia impetiolaris*, Toro *314*, sub *Dothidina sphaerospora*, Medellin, Jan. 20, 1928, Type.   Chardon herb.

5. BAGNISIOPSIS TOLEDOI Chardon, Myc. Explor. Ven., Monogr. Univ. of Puerto Rico, ser. B. **2**: 137.   1934.

Type: Chardon & Guiscafré, Myc. Explor. Ven. *565*.   Cornell herb.

Stromata hypophyllous, isolated or in groups, separated or coalesced in masses, in small spots, erumpent and superficial at maturity, sessile, constricted underneath and attached to a hypostroma in mesophyll, orbicular and applanate on top or hemispherical or almost globose, .2–1.5 μ mm. in diam., compact groups sometimes up to 3 mm. in diam., black, with smooth or roughened surface, with prominent black, seta-like processes, cylindrical to conical, sometimes dilated at the apices, 20–50 μ high and 10–20 μ in diam.; locules 1–15 in each stroma, globose to irregular, 200–285 × 143–230 μ, with no distinct wall, with conical ostiole immersed in stroma; asci cylindrical, p. sp. 58–83.6 × 10–14 μ with long attenuate stalks, 80–110 μ in length; spores 8, uniseriate, occasionally turned cross-wise, continuous, hyaline becoming light brown at maturity, broadly elliptical, 7.6–16 × 7.6–11.4 μ, chiefly 12 × 8 μ, with epispore uniform, .5 μ thick; paraphysoids filiform, numerous, somewhat branched.

No conidia were observed.

Hosts: *Clidemia Fendleri*, *Heterotrichum cymosum*, *Miconia grandifolia*, *M. laevigata*, *M. macrophylla*, *M. prasina*, and *Miconia* sp.

Distribution: Puerto Rico, Venezuela.

This species is similar in most respects to *B. amadelpha*, differing in the possession of smaller spores, which do not have the apical and lateral thickening of the wall.   Both have the black conoid processes growing from the stromal surface.   The dark crust distinguishes them from *B. minuta* and *B. translucens*.

Chardon (**2**) did not describe the surface projections in his original description.

Puerto Rico. On *Heterotrichum cymosum*, Whetzel, Kern & Toro *2499*, sub *D. peribebuyensis*, Yanco, June 17, 1924, N. Y. B. G. and Cornell Herbs.

On *Miconia laevigata*, Whetzel, Kern & Toro *2606*, sub *D. peribebuyensis*, Maricao, July 6, 1924. N. Y. B. G. and Cornell herbs.

Venezuela. On *Clidemia Fendleri*, Chardon & Stelling *841*, sub *B. Toledoi*, Carabobo, Aug. 7, 1932. Cornell herb.

On *Miconia grandifolia*, Muller *1899*, sub *B. peribebuyensis*, Petare, May 14, 1937; on *Miconia macrophylla;* Chardon & Guiscafré *565*, sub *B. Toledoi*, Los Teques, Miranda, July 13, 1932, Type, and Chardon *1219*, sub *B. Toledoi*, La Granja, Tachira Sept. 14, 1932; Tamayo and Chardon *3407*, sub *B. peribebuyensis*, Los Teques, Apr. 16, 1939; on *Miconia prasina*, Chardon *2632*, sub *B. peribebuyensis*, Aragua, Apr. 30, 1938; On *Miconia* sp.; Whetzel & Muller *2841*, sub *B. peribebuyensis*, Tecupe, Feb. 28, 1938; Whetzel & Muller *3097*, sub *B. peribebuyensis*, Miranda, Apr. 13, 1939; Whetzel & Muller *3394*, sub *B. tijucensis*, Miranda, Apr. 13, 1939. Above in Cornell herb.

6. BAGNISIOPSIS AMADELPHA (Syd.) Petrak, Hedwigia **68**: 280. 1928.

Dothidina amadelpha Sydow, Ann. Myc. **23**: 387. 1925.

Type: Sydow *149*, on *Miconia furfuracea*, Costa Rica, in Sydow Herb.

Stromata hypophyllous, sparsely scattered or in small groups in orbicular, yellow to brown spots, 1–6 mm. in diam., chiefly evident in the epiphyll, with hypostroma in mesophyll, 100–150 μ in diam., erumpent to superficial at maturity, semiglobose to depressed disciform, 200–700 μ in diam., with surface smooth and regular, black, hard coriaceous when dry, soft fleshy when wet, with conoid dispersed setae-like processes on sides and top, more or less dilated at apices, 20 to 50 μ high and 10–20 μ wide in the middle; locules usually solitary or 2–4 in the stroma, with no special wall, with conical ostioles entirely immersed; asci cylindrical with apices rounded, with long attenuated stipes; 8 spored, p. sp. 78–130 × 12–17 μ, with stipe 50–80 μ in length; spores uniseriate or obliquely uniseriate, continuous, oblong-ellipsoid to broadly ovate, hyaline, becoming dilute to dark brown with age,

11.4–22.8 × 7.6–11.4 μ, chiefly 18 × 9 μ, with epispore .5 μ wide, but 1.5–2 μ thick at apices and on one side; paraphysoids filiform, somewhat branched, numerous.

No conidia observed.

Hosts: *Tibouchina* sp., *Miconia furfuracea*, *Miconia* sp., and *Clidemia grandifolia*.

Distribution: Colombia, Costa Rica, and Venezuela.

The type of this species has not been distributed in America, and so the writers did not have access to it, but unhesitatingly place the following collections here on Sydow's description.

When considered together there are three distinctive characters; the stroma of more constantly regular shape than in other species, the presence of the short projections, and the large spores with ends and one side thickened. The processes, as Sydow names them, are black and carbonous on the surface with an interior composed of very delicate hyaline hyphae with many nuclei. In cross section they have the appearance of elongate pycnidia parasitizing the stroma.

The ascospores are variable, but average somewhat larger in these specimens than the 12–18 × 7.5–9 μ given by Sydow.

<div align="center">MATERIAL EXAMINED</div>

Colombia: On *Miconia* sp., Chardon and Nolla *443*, sub *D. peribebuyensis*, El Valle, June 9, 1929, Cornell herb.

On *Tibouchina* sp., Chardon *249*, sub *P. peribebuyensis*, Medellin, August 10, 1926, det. Sydow. Chardon herb.

Venezuela: On *Clidemia grandifolia*, Chardon *2642* and *2643*, sub *B. peribebuyensis*, Aragua, April 30, 1938, Chardon and Cornell herb.

7. **Bagnisiopsis minuta** (Sydow) comb. nov.

Sucinaria minuta Sydow, Ann. Myc. **23**: 363.   1925.

Type: Sydow *272*, Costa Rica.

Stroma dispersed, hypophyllous, in small spots, at first yellowish green, later ochraceous or reddish brown, 1–3 mm. in diam., gelatinous carnose, with orbicular outline, 400–800 μ in diam., pustulate to verruciform, collapsing when dry, 250–300 μ high, with plane or slightly concave surface, rarely convex, erumpent then superficial, with equally dispersed, conical projections about

75 μ high; locules more or less numerous, monostichous, entirely immersed, globose or ovate-globose, or angular 140–200 μ in diam., with truncate-conical ostioles; asci cylindrical, with rounded apices, and attenated stalk about 40 μ in length, 8-spores, p. sp. 66–75 × 9–11 μ; ascospores uniseriate, broadly ovate or elliptical, occasionally globose, with rounded ends, continuous, hyaline later yellowish, 8–10 × 6.5–7.5 μ; paraphysoids numerous, usually simple, filiform about 1–1.5 μ thick.

No conidia observed.

Host: *Miconia Thomasiana*.

Distribution: Known only from type locality in Costa Rica.

The pale brown fleshy stroma distinguishes this species from all others except *B. translucens*, from which it differs in possession of smaller spores.

Sydow (8) in his drawing shows a definite wall surrounding each locule, such as one would find in the Hypocreaceae in which he placed *Sucinaria*. The writers fail to see this wall in his specimen.

Petrak (5), while demonstrating the relationship of this species with *Bagnisiopsis*, did not actually make the combination. This, along with *B. translucens*, show such close affinities with *B. tijucensis* that it does not seem logical to continue *Sucinaria*, or even .create a new section of *Bagnisiopsis*.

MATERIAL EXAMINED

Costa Rica: On *Miconia Thomasiana*, Sydow *272*, Los Angeles de San Ramon, Jan. 30, 1925. Type, U. S. D. A. Myc. Coll.

8. **Bagnisiopsis translucens** sp. nov.

Type: Whetzel and Muller, Ven. Myc. Explor. *3010*, Cornell Herb.

Stromata hypophylla, late dispersa vel raro 2–5 aggregata, in maculis minutis, indistinctis, erumpentia, mox omnino superficialia, ambitu orbicularia, .5–1.5 mm. in diam. et .5 mm. alta, superficie flavo-brunneoli, plana vel leniter convexa, basi leniter contracta, in superiore parte tuberculosa processibus conoideis, 60-80 μ altis et in medio 30–40 μ, contextu dilute flavido gelatinoso; loculi 1–10, monostichi, omnino immersi, globosi vel obtuse angulati, ostiolo conoideo immerso; asci copiosi, cylindricei, longo stipitati, p. sp. 76–130 × 10–12 μ et stipite 90–130 μ longo; sporae 8, monostichae, ellipsoideae vel oblongo-ellipsoideae, utrinque late rotundatae, continuae, hyalinae, tandem dilute brunneolae, 11.4–19 × 7.6–9.5 μ; paraphysoides numerosae, filiformae.

Stromata hypophyllous, broadly dispersed or rarely 2–5 in groups, in small indistinct spots, erumpent, later entirely superficial, with orbicular outline, .5–1.5 μ in diam. and .5 μ high, with yellowish-brown surface, plane or slightly convex with base slightly contracted, tuberculous in the upper part with conoid processes, 60–80 μ high and 30–40 μ through the middle, with context dilute yellowish, gelatinous; locules 1–10, monostichous, entirely immersed, globose or obtusely angular, with conoid immersed ostiole; asci copious, cylindrical, long stipitate, p. sp. 76–130 $\times$ 10–12 μ and stalk 90–130 μ in length; spores 8, monostichous, ellipsoid or oblong-ellipsoid, with ends broadly rounded, continuous, hyaline, later dilute brown, 11.4–19 $\times$ 7.6–9.5; paraphysoids numerous, filiform.

No conidial stage was found.

Host: *Miconia* sp.

Distribution: Known only from Venezuela.

This species differs from all others studied except *B. minuta*, chiefly in the very light brown, almost translucent wall with the short black warts. The setae in *B. Toledoi* and *B. amadelpha* are somewhat narrower and more cylindrical.

<div align="center">MATERIAL EXAMINED</div>

Venezuela: On *Miconia* sp.: Whetzel and Muller *3010*, sub *B. tijucensis*, Colonia Tovar, near Caracas, Mar. 12, 1939, Type; Barrus and Muller *3652*, sub *Bagnisiopsis* sp., San Antonio de Los Altos, Miranda, Dec. 8, 1939; M. F. Barrus *3736*, sub *Bagnisiopsis* sp., Chirgua, Carabobo, Dec. 16, 1939. Above in Cornell herb.

<div align="center">SPECIES EXCLUDED</div>

9. Bagnisiopsis Miconiae (Duby) Petrak, Hedwigia **68**: 275. 1928.

> *Sphaeria Miconiae* Duby, Mem. Soc. Phys. Hist. Nat. Geneva **7**: 405. 1836. *Tab. 1, fig. 1.*
>
> *Physalospora Miconiae* (Duby) Sacc. Syll. Fung. **1**: 447. 1882.
>
> *Botryosphaeria Miconiae* (Duby) Hohnel, Sitz-ber. Akad. Wien. **118**[1]: 836. 1909.
>
> *Phyllachora Miconiae* (Duby) Sacc. Ann. Myc. **11**: 547., 1913.

Neither Theissen and Sydow nor Petrak saw the Duby type, and the former (11) do not place it in their monograph because Duby describes stromata appearing in the epiphyll, while all known ones are in the hypophyll. Petrak (5) thinks this Duby statement was a mistake, and after examining Ule no. *3402*, decides it is fully equal to the rest of Duby's description. This specimen is also from Brazil, and is on the same host, *Miconia calvescens*, as the type. Petrak then redescribes the species and gives spores as broadly elliptical to almost spherical, 7.5–11 × 7–8.5 μ. Duby also describes spherical spores.

This amended description by Petrak fits the Chardon *B. sphaerospora* very well, but the writers hesitate to accept his concept in view of the very fragmentary diagnosis of Duby and no available type specimen.

10. BAGNISIOPSIS MELASTOMATUM (Lév.) Petrak, Ann. Myc. **32**: 408. 1934.

   Sphaeria melastomatum Lév. Ann. Sci. Nat. III. **3**: 54. 1845.
   Laestadia melastomatum (Lév.) Sacc. Syll. Fung. **1**: 428. 1882.
   Stigmatea melastomatum (Lév.) Sacc. Add. **1**: XLIII. 1883.
   Stigmatula melastomatum (Lév.) Syd. Bull. Herb. Boiss. I. **2**: 78. 1901.

This species was in neither the Theissen and Sydow (11) nor Petrak (5) monographs. The latter examined the type later and amends the original description. His diagnosis of stromata, and spore measurements, 10–15 × 5–7 μ, agree very well with his earlier description of *B. minutula*, which the writers have under *B. Leandrae*. There is further evidence for this view in his statement that this species differs from *B. tijucensis* in the smaller spores. This is the same as in the case of *B. minutula*. However, as the type of *B. melastomatum* is not available for study the writers hesitate to place it in that position.

11. BAGNISIOPSIS MEXICANA (Sacc.) Petrak, Ann. Myc. **27**: 368. 1929.

   Phyllachora mexicana Sacc. Ann. Myc. **11**: 546. 1913.

Theissen and Sydow (11) have this species in excluded Phyllachorae, but as a synonym under *P. laurina* Cooke. They think the host is not in the Lauraceae but is a *Miconia*.

Petrak not only places *P. mexicana* in *Bagnisiopsis*, but says Theissen and Sydow were mistaken, and that *P. laurina* is distinct and is a *Bagnisiopsis* near *B. gibbosa*. Saccardo gives spores of *B. mexicana* as 12–14 × 9–11 μ which would place it near *B. tijucensis*. Types of *P. mexicana* and *P. laurina* have not been studied by the writers.

12. BAGNISIOPSIS ORELLANA Sydow, Ann. Myc. **37**: 368.   1939.

Type: Sydow *201*, on *Miconia crocea*, in Equador.   Spores are described as 9.5–13.5 × 7–9 μ.

13. BAGNISIOPSIS PUYANA Sydow, Ann. Myc. **37**: 370.   1939.

Type: Sydow *882*, on *Miconia pujana*, in Equador.   He gives these spores as 10–15 × 5.7–7.5 μ.

The writers have been unable to locate type specimens of the above two.   It appears probable that Sydow never distributed parts of these specimens in the United States.   His published diagnoses could fit either *B. tijucensis* or *B. Leandrae*.

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LITERATURE CITED

1. **Chardon, C. E.** Pyrenomycetes of Puerto Rico. Mycologia **13**: 289. 1921.
2. **Chardon, C. E. & R. A. Toro.** Myc. Exp. of Ven. Monog. of Univ. of P. R. B. **2**: 138-9. 1934.
3. **Clements, F. E. & C. L. Shear.** The genera of fungi. pp. 496. The H. W. Wilson Co., N. Y. 1931.
4. **Petrak, F.** Myk. Notizen 595. Über die Gattung *Hemidothis* Syd. Ann. Myc. **25**: 326–328. 1927.
5. **Petrak, F.** Über *Bagnisiopsis* und verwandt Gattung. Hedwigia **68**: 251–290. 1928.
6. **Petrak, F.** Myk. Notigen, 660. Über Höhnels Auffassung der Gattung. *Hemidothis* Syd. Ann. Myc. **27**: 374. 1929.
7. **Saccardo, P. A.** Syll. Fung. **9**: 1017. 1891.
8. **Sydow, H.** Fungi in itinere costaricensi collecti. Ann. Myc. **23**: 308–429. 1925.
9. **Sydow, H.** Fungi venezuelani. Ann. Myc. **28**: 29–224. 1930.
10. **Sydow, H. & P.** Fungi Amazonici a. cl. E. Ule. lecti. Ann. Myc. **14**: 65–97. 1916.
11. **Theissen F. & H. Sydow.** Die Dothideales. Ann. Myc. **13**: 149–746. 1915.

HOST INDEX FOR EUBAGNISIOPSIS

Blakea sp.
  B. tijucensis
Clidemia Fendleri
  B. Toledoi
Clidemia grandifolia
  B. amadelpha
Clidemia impetiolaris
  B. sphaerospora
Heterotrichum cymosum
  B. Toledoi
Leandra cordifolia
  B. Leandrae
Miconia ambigua
  B. peribebuyensis
Miconia argentea
  B. peribebuyensis
Miconia Beurlingii
  B. peribebuyensis
Miconia Candolleana
  B. peribebuyensis
Miconia flammea
  B. tijucensis
Miconia furfuracea
  B. amadelpha
Miconia grandifolia
  B. Toledoi
Miconia laevigata
  B. peribebuyensis
  B. Toledoi
Miconia lepidota
  B. tijucensis
Miconia macrophylla
  B. tijucensis
  B. Toledoi

Miconia Pilgeriana
  B. Leandrae
Miconia prasina
  B. peribebuyensis
  B. Toledoi
Miconia Thomasiana
  B. minuta
Miconia ulmarioides
  B. tijucensis
Miconia sp.
  B. amadelpha
  B. peribebuyensis
  B. Toledoi
  B. translucens
  B. tijucensis
Monochaetum hirtum
  B. peribebuyensis
Tetrazygia elaeagnoides
  B. peribebuyensis
Tibouchina longifolia
  B. tijucensis
Tibouchina multiceps
  B. tijucensis
Tibouchina paniculata
  B. tijucensis
Tibouchina sp.
  B. amadelpha
  B. tijucensis
Melastomaceae Undet.
  B. peribebuyensis
  B. tijucensis

THE SPERMODOCHIDIUM, AN UNUSUAL TYPE OF SPERMATIAL FRUIT-BODY IN THE ASCOMYCETES [1]

H. H. WHETZEL

In 1851, Tulasne,[2] in a paper on the reproductive apparatus of the Lichens and Fungi, written in French, designated what were then generally regarded as the male organs and male gametes of the Lichens as "*spermogonies*" and "*spermaties*" respectively. In 1852,[3] in a mémoire on the Lichens, he again made use of these terms but gave to them Latin forms—*spermagonia* and *spermatia*.

In 1853, de Bary [4] adopted the terms spermogonia and spermatia for the homologous organs and their products in the Rust Fungi, and he thus followed a suggestion that had been made by Tulasne in 1851.

Finally, in 1861, in his Selecta Fungorum Carpologia,[5] Tulasne extended the application of the terms spermogonia and spermatia to homologous organs in the Pyrenomycetes and other Ascomycetes.

In 1884, in his text-book on the Morphology and Physiology of the Fungi, de Bary followed Tulasne in the general application of the terms spermogonia and spermatia to the Lichens and various groups of the Ascomycetes.

In his discussion of the polymorphic stages in the life-history of certain Sphaeriales, Tulasne [6] distinguished between a spermogonium and a pycnidium, on the basis of the size and power of germination of the cells which are set free in their cavities.

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[1] It is with much pleasure that I acknowledge the kindly critical assistance of Dr. A. H. R. Buller in the preparation of this paper.

[2] Comptes Rendus 32: 470–475, 1851 and Ann. Sci. Nat. III. 15: 372–373, 1851.

[3] Ann. Sci. Nat. III. 17: 157, 1852.

[4] Die Brand pilze, p. 59–62. 1853.

[5] P. 57, 181.

[6] Sel. Fung. Carp. 1: 58, 1861.

A spermogonium is a fruit-body having a hyphal wall from the inner layer of which, on the bottom and sides, arise spermatiophores from the tips of which the spermatia are usually produced in a successive series, thus filling the cavity with a mucilaginous mass of these minute spore-like bodies. Tulasne's descriptions and illustrations of spermogonia in the various species which he investigated emphasize the fact that the walls of a spermogonium are constructed from fungus hyphae.

The spermatial fruit-body of many Discomycetes, as is now known,[7] is not enclosed in a hyphal wall, but takes the form of a naked sporodochium, the spermatiophores arising from a central or basal hyphal-centrum. To this type of spermatial fruit-body I have given the name *spermodochium*.[8]

There is another type of spermatial fruit-body, simulating a spermogonium externally, but internally of a very different construction. This type of spermatial fruit-body is characteristic of those species of *Sclerotinia* that attack certain members of the Cyperaceae and Juncaceae, as for example *S. Duriaeana* Tul., *S. longisclerotialis* Whet., and *S. scirpicola* Rehm. In these species the spermatia are produced within lysigenous cavities in the diseased culms. These cavities, which lie just beneath the epidermis and between the vascular bundles, result from the destruction, by the fungus, of the thin-walled cortical cells. Here, arising on ramifying hyphae, are produced many globose spermodochia which, together with the accumulating mucilaginous mass of spermatia, fill the cavity to bursting. The epidermal covering is eventually ruptured by a slit and the mass of spermatia ooze forth in a sticky, olivaceous drop. Viewed from the exterior, the spermatial fruit-bodies appear as dark-brown or black pycnidia. When fresh or moist, they are swollen or tuberculate. When dry, they appear as narrow brown lines or as minute oval discs, variously distributed along the diseased culms. The dark color of these fruit-bodies is due primarily to the olivaceous-brown color of the massed spermatia and spermatio-

[7] Whetzel, H. H. Mycologia 29: 135. 1937.
[8] Although modern dictionaries validate the spelling of spermogonia and its derivatives with either an *o* or an *a*, the original spelling with the *o* is to be

phores within.   The spermatia and spermatiophores, viewed singly under the microscope, appear to be nearly or quite colorless.

The cavity in which the spermodochia are housed is very different from that of a typical spermogonium.   The walls of the cavity enclosing the spermodochia consist of the surrounding *undigested cells of the suscept tissues*.   There is no hyphal wall enclosing the massed spermodochia and spermatia.   Spermatiophores do not arise from the periphery of the cavity as they do in a true spermogonium.   The structure of a cavity enclosing spermodochia, as seen in cross-section, is accurately illustrated for *S. longisclerotialis* in Mycologia **21**: *Fig. 23*.

Since the spermatial fruit-bodies above described are so very different in structure from true spermogonia, they merit a distinctive appellation.   I, therefore, propose the name SPERMODO-CHIDIUM [9] (pl. *spermodochidia*) to designate a spermatial fruit-body in which spermodochia are housed in a distinctive lysigenous cavity in the tissues of the suscept.

Tulasne [10] appears to have been the first to illustrate the internal structure of the spermodochidium in a species of *Sclerotinia* attacking a *Carex*.   He was concerned with the spermatial fruit-body of *S. Duriaeana* in the culms of *Carex brizoides* L. (erroneously, *C. arenaria* L.).   It should be noted that he does not refer to this body as a spermogonium, but uses instead the generic name, *Epidocium*.   It is evident, however, that he was influenced in his description and in the delineation of his figure 21 by his spermogonial concept, for he speaks of the "fertile walls and loose filaments of the fungus" in describing (p. 186) the cross-section in his illustration.   He represents in this drawing a rather indefinite pseudoparenchymatous wall lining the cavity, with a few spermatiophores arising from the wall but, strangely enough, along its upper part only.   His details of the structure of the globose spermadochia packed in the cavity are accurately rendered However, he is in error in showing a fungal wall lining the cavity, with spermatiophores arising therefrom.   I have carefully studied thin cross-sections of the spermodochidia of *S. Duriaeana*—the

[9] I am indebted to Dr. A. H. R. Buller of the University of Manitoba and Dr. V. M. Cutter of Cornell University for the coinage of this term.

[10] Sel. Fung. Carp. **3**: *pl. 22, fig. 21*, 1865.

same species with which Tulasne worked—and have found no trace of a fungal wall.   Tulasne evidently mistook the brown walls and contents of the *Carex* tissues lining the cavity for a fungal pseudoparenchyma.   The few spermatiophores which he shows arising from a limited area in this supposed wall may have been detached and misplaced in cutting the section.   Thus, in a new situation, may the preconceived concept of a given organ occasionally lead even the most careful and accurate observer into error.

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A NEW NEMATODE-CAPTURING DACTYLELLA AND SEVERAL RELATED HYPHOMYCETES

CHARLES DRECHSLER

(WITH 4 FIGURES)

In two earlier papers (**2, 3**) descriptive accounts were given of twenty-one interrelated mucedinaceous fungi observed capturing and consuming actively motile eelworms in transparent agar plate cultures planted with softened discolored rootlets or, at times, with various other decaying materials. A twenty-second mucedinaceous fungus of similar predaceous character and having taxonomic kinship in the same intimate series is described herein as a new species. Occasion is taken to describe likewise as new species three hyphomycetous forms which together with a fourth form identified as *Dactylaria pulchra* Linder (**7**) apparently also belong in the series, though so far none of the four have been demonstrated either to capture microscopic animals or to subsist habitually as parasites.

ANOTHER CONSTRICTING DACTYLELLA WITH BROAD BISEPTATE CONIDIA

A maizemeal-agar plate culture that after being permeated with mycelium of *Pythium ultimum* Trow had received on May 13, 1941, some addition of decaying bluegrass leaves taken three days earlier from a heap of lawn clippings in Arlington, Va., revealed on May 27 a sparse array of tall colorless conidiophores, each bearing terminally a single large biseptate colorless conidium of distinctive prolate ellipsoidal shape. In accordance with expectations suggested by their general resemblance to the fertile hyphae more especially of the nematode-capturing species I presented earlier as *Dactylella bembicodes* (**2**) and *D. doedycoides* (**3**), the tall conidiophores were found arising from a mycelium that manifestly was nourished on the fleshy contents of eelworms held fast and strangled by it. During the ensuing two weeks the predaceous mycelium spread throughout the Petri plate culture,

giving rise here and there to additional conidial apparatus in quantity commensurate with the somewhat meager supply of living prey. Since this prolonged development took place at laboratory temperatures ranging between 28° and 32° C.—at temperatures mostly too high for abundant predaceous development of any large-spored *Dactylella* then known to capture eelworms—it was evident that the fungus here concerned differed from familiar allied species in its thermal adaptations as well as in the outward form of its conidia. Pure cultures obtained through removal of the conidia to sterile agar media soon brought to light accessory reproductive bodies expressive of further distinctiveness.

In pure culture on maizemeal agar the fungus grows with moderate rapidity to produce a colorless mycelium composed of branching hyphae divided by cross-walls into segments of moderate lengths. Owing to a somewhat promiscuous arrangement of the hyphae the mycelium in the transparent medium has a dull appearance without the luster usual in mycelia of such species as *Arthrobotrys dactyloides* Drechsl. and *Dactylaria brochopaga* Drechsl. (2), both of which extend their filaments in more nearly parallel arrangement. The younger hyphae contain clear homogeneous protoplasm wherein granules of variable size are distributed rather sparingly. During the younger·stages of hyphal development, no less than during the later increasingly vacuolate stages, the pore of each septum is guarded on both sides by granules of the type discussed by Buller (1: p. 128) as "Woronin bodies." Ordinarily when maizemeal-agar cultures are kept free of alien organisms and protected against mechanical disturbances they show no development of special apparatus for capture of prey.

Nematode-infested agar cultures afford only rather sparse mycelial development of the fungus. Along the straightforward rangy hyphae creeping over the infested substratum, or lying horizontally submerged under its surface, predaceous organs are produced which, as in *Arthrobotrys dactyloides, Dactylella bembicodes, D. doedycoides, Dactylaria brochopaga,* and *Trichothecium polybrochum* Drechsl. (2), consist of three-celled constricting rings, each attached by a curving two-celled stalk. Although these

rings commonly originate in positions beneath the parent filament and in planes approximately at right angles to it, they often are jostled by passing nematodes into more nearly horizontal postures, so that their cellular make-up may then conveniently be viewed flatwise (FIG. 1, *A*, *a*, *b; B*, *a*, *b; C–F*).   When a ring is thus viewed the aperture framed by the inner contour of its three arcuate segments is not smoothly circular or smoothly elliptical like the outer contour, but appears in some degree scalloped, owing to the presence of a median thickening on the inner side of each segment.   Usually, as in other species, the arcuate segment of distal origin anastomoses somewhat more broadly with the arcuate segment of proximal origin than with the adjacent distal cell of the stalk.   The stalk itself most closely resembles that of *D. doedycoides*, being perceptibly longer and slenderer than the homologous part of any of the four other species so far made known as capturing eelworms by means of constricting rings. Naturally the somewhat greater length of the stalk entails no difference in the manner in which the remarkable annular trap closes upon an intruding animal.   The three arcuate cells here, just as in the short-stalked species, swell and contract abruptly to hold the hapless animal and at the same time to bring about its disablement promptly, so that the assimilative hyphae may the sooner be extended into its fleshy body.   In some instances, especially where the prey is relatively small and weak, subsequent development likewise follows the same course as in the short-stalked forms—the fungus protoplasm elaborated by the assimilative hyphae at the expense of the animal's substance, being transferred to the parent mycelium by way of the stalk (FIG. 1, *G*). However, in other instances, especially where a comparatively large and vigorous captive has been taken, the stalk suffers injury from the animal's struggles.   To remedy such injury a new hyphal connection is established.   If, for example, the proximal cell of the stalk has been damaged severely enough to require evacuation of its contents, the distal cell may extend a short branch obliquely backward to anastomose with the parent filament (FIG. 1, *H*), thereby opening a new avenue for movement of elaborated protoplasm.   If the stalk as a whole has been subject to severe wrenching, a new hyphal connection may be formed to unite the

parent filament with the swollen distal segment of the ring (FIG. 1, *I, a*).   It seems probable moreover, that even where the stalk has not been perceptibly damaged an additional hyphal communication is frequently formed merely to furnish a supplementary channel for transfer of the materials elaborated in the expropriation of a large captive.   Replacement of an injured stalk, or on occasion, presumably, development of a supplementary connection, occurs likewise in *D. doedycoides;* the published figure of that species showing a ring that after having functioned in the capture of a nematode had established a second connection between its proximal swollen cell and the parent filament (3: p. 455, FIG. 1, *II*).

After the mycelium in a nematode-infested culture has been active for some time in destroying prey, it gives rise here and there to erect conidiophores (FIG. 1, *J, a, b; K*) generally similar to those of *Dactylella bembicodes*.   They resemble, with respect to stature and septation, also the conidiophores of *D. doedycoides*, but as a rule lack the bulbous apical modification which suggested the epithet of that species.   Like the tall conidiophores of *D. doedycoides*, again, they bear large, predominantly biseptate, solitary conidia (FIG. 1, *J, a; L, a–u*), consisting typically of a small basal cell, a large median cell, and a small apical cell.   When its primary function has been served, a conidiophore usually falls over on to the substratum, and then often sends up from one or·another of its wider basal segments a new conidiophore of similar stature. Occasionally, indeed, an old conidiophore may by lateral branching from a basal segment give rise to a new one even while it is still maintaining a more or less erect posture.

Although the large conidia of the present fungus resemble the homologous spores of *Dactylella doedycoides* with respect to septation, they are distinguished from the latter not only by their generally greater length and lesser diameter, but also by their prolate ellipsoidal rather than broadly turbinate shape.   Viewed at an angle perpendicular to its axis, the detached conidium, like that of *D. doedycoides*, presents at its base a sharply truncate outline along the plane of disarticulation.   A minute but distinct basal protrusion, absent in *D. doedycoides*, removes the truncate portion of profile from alignment with the main elliptical profile of the spore.   After falling on moist agar substratum the de-

tached conidia germinate readily, often putting forth one (FIG. 1, M) or two (FIG. 1, N) germ tubes from the basal segment, or emitting a germ tube from both the basal and the terminal cell (FIG. 1, O). Frequently, again, germination takes place by the production of a germ conidiophore on which is borne a secondary conidium similar to the primary one except in its noticeably smaller dimensions (FIG. 1, P).

Erect aerial conidiophores of the same type as those produced sparingly by the fungus in nematode-infested cultures are formed more abundantly in pure cultures prepared with maizemeal agar (FIG. 2, A, B). Some little tendency toward reduced height is often recognizable here in an increased proportion of moderately short conidiophores. Often, too, the conidiophores formed in pure culture appear less markedly differentiated from mycelial hyphae than in eelworm-infested cultures; the lesser differentiation coming to light in smaller basal diameter, reduced tapering, greater apical width, and more frequent haphazard flexures. This obliteration of structural features ordinarily distinguishing filaments given over to production of the large conidia is even accompanied now and then by loss of the erect aerial habit; for in pure cultures some conidiophores are produced completely submerged under the surface of the maizemeal-agar medium and in positions parallel with this surface. Such intramatrical development of conidiophores has not hitherto been observed in any other member of the predaceous series of hyphomycetes, though several hyphomycetes parasitic on nematodes, including *Harposporium anguillulae* Lohde and the species I described (**4**) under the binomials *H. helicoides*, *H. oxycoracum*, *H. diceraeum*, and *Meria coniospora* readily form their conidia within a soft agar medium, especially in instances where the animal host has succumbed well below the surface.

The large conidia borne intramatrically on submerged hyphae, as also the similar conidia (FIG. 2, *C, a–z*) produced in pure culture on the tall erect hyphae, show no marked difference with respect to size, shape, septation, or germination (FIG. 2, *D, a, b*), from those formed in nematode-infested cultures. In mounts made from actively sporulating cultures, a small proportion of the conidia referable to the type under consideration contain only a

single cross-wall (FIG. 1, *L, a, b, c;* FIG. 2, *C, b, h, q, r, s, w*) which nearly always corresponds in position to the basal cross-wall of the preponderant biseptate specimens.   Since, for the most part, absence of a second cross-wall would seem attributable here to immaturity, it was deemed advisable not to include either uniseptate or unseptate specimens of the large conidia in making the measurements utilized in drawing up the diagnosis.   The relevant metric data submitted in the diagnosis are thus based wholly on measurements of biseptate specimens, 100 in number, whereof 50 were taken at random from a pure culture, and 50 from a nematode-infested culture.   The 100 values for length, expressed to the nearest integral number of microns, are distributable as follows: 35 μ, 1; 36 μ, 6; 37 μ, 9; 38 μ, 10; 39 μ, 12; 40 μ, 20; 41 μ, 17; 42 μ, 10; 43 μ, 6; 44 μ, 5; 45 μ, 2; 46 μ, 1; 47 μ, 1; while the values for width are distributable thus: 13μ, 4; 14 μ, 3; 15 μ, 16; 16 μ, 27; 17 μ, 28; 18 μ, 13; 19 μ, 5; 20 μ, 4.

After development of large conidia is well under way, the fungus in pure culture on maizemeal-agar plates gives rise at the tips of prostrate filaments (FIG. 2, *E, a*) and more especially at the tips of short lateral branches (FIG. 2, *E, b–e*) borne at intervals on such filaments, to smaller, elongated, somewhat curved, regularly uniseptate conidia (FIG. 2, *F, a–z*).   The individual filament or branch, having formed one of these smaller conidia, continues development by growing out laterally a short distance below its tip, and on the tip of the spur thus produced forms a second, similarly uniseptate, elongated, curved conidium.   With repetition of the process additional conidia are formed, and the sporiferous element is prolonged into a rather crooked, prominently spurred rachis.   The elongating rachis soon comes to lie in large part prostrate on the surface of the substratum, although the two or three youngest spurs retain usually an erect or ascending posture, and as a result the young conidia attached to or being produced on them are commonly found extending into the air.   Disarticulation evidently takes place very readily, for the mature conidia are mostly found strewn about on the substratum near the denuded rachis from which they came.

Detached conidia of the smaller type are not sharply truncate at the base like the larger conidia, but usually have a profile that

is only a little less smoothly rounded at the proximal end than at the distal end. The single cross-wall dividing them is most often laid down somewhat below the middle, though its insertion in an approximately median position is not infrequent (FIG. 2, *F, a, e, h, s, t, y*). Now and then it is placed slightly above the middle (FIG. 2, *F, c, i*), or, again, so far below the middle that the distal segment may be nearly three times as long as the proximal segment (FIG. 2, *F, v*). Whatever the position of its cross-wall the small conidium germinates without difficulty, often by putting forth a germ tube from the basal end (FIG. 2, *G, a, b*) or from both the basal and the apical end (FIG. 2, *G, c*). Germ tubes of such origin, much like ordinary hyphae, anastomose freely with mycelial filaments (FIG. 2, *G, d*).

The smaller conidia are filled with protoplasm which though often somewhat more granular than the protoplasm of the larger conidia is otherwise apparently of similar character. The contrast of outward shape is therefore not associated here by any pronounced difference in internal organization, such as is evident in *Dactylella doedycoides*, where the elongated conidioid bodies produced sparingly on short erect branches contain numerous globules in curiously distinctive arrangement. Often the contrast in outward shape is impaired to some degree through the occasional production on the tall conidiophores—perhaps, more especially, on germ conidiophores (FIG. 1, *P*)—of rather narrow, straight or curved conidia (FIG. 1, *L, b, d, e;* FIG. 2, *C, x*) intergrading variously with conidia formed on the short prostrate branches. However, the distinction between the two types of spores is here not as badly obscured by intergradation as in *Arthrobotrys dactyloides*, where biseptate swollen conidia, if formed at all, are borne on tall conidiophores of the same kind as those bearing the uniseptate elongated conidia, and, indeed, are often borne promiscuously intermingled in the same head with the uniseptate conidia.

In pure culture on maizemeal agar the fungus also produces, mainly under the surface of the substratum, numerous resting bodies consisting frequently of a simple intercalary chain of ten to twenty inflated hyphal segments filled with globuliferous contents (FIG. 2, *H*). Very often, again, they are more complex in

their makeup and include, in addition to the segments derived by modification of an axial filament, an equal or even larger number of segments derived from proximal portions of several branches (FIG. 2, *I*). Both in simple and in branched resting bodies the median segments are more strongly distended and contain larger globules than the more remote segments, which usually show gradual transition toward the unmodified character of the outlying mycelium. The distended cells have a faintly yellowish coloration, and are provided with walls noticeably thicker than the membranes surrounding ordinary hyphae, though the thickening is not pronounced.

Despite their conspicuously multicellular make-up and only moderate induration the rangy resting bodies appear homologous with the chlamydospores of *Arthrobotrys oligospora* Fres. and of the three allied nematode-capturing species I described (2) under the binomials *A. conoides*, *A. musiformis*, and *Dactylaria thaumasia*. These chlamydospores, it is true, are predominantly unicellular, yet cultures of *A. oligospora* sometimes reveal a fairly generous admixture of two-celled specimens, while cultures of *A. conoides* may contain not only a liberal admixture of both two-celled and three-celled specimens, but also occasional specimens composed of four or even five cells. Owing to their thicker walls and deeper yellowish coloration, the chlamydospores of the four species mentioned offer an appearance more strongly suggestive of endurance under unfavorable conditions than is offered by the rangier resting bodies. With respect to desiccation, at least, this hardier appearance may not be unwarranted. Cultures of *A. oligospora*, *A. conoides*, and *D. thaumasia*, which were planted in tubes of maizemeal agar in March 1938, and which fifteen months later were removed from a refrigerator to be kept in the laboratory without protection from evaporation, produced an abundance of new conidia following addition of sterile water in April, 1942, though the agar substratum had then for fully thirty months been in a completely air-dry state, with the hardness and consistency of horn. However *A. musiformis*, tested in parallel cultures with the other forms, failed to revive; so that its chlamydospores would seem to be of somewhat lesser endurance.

As the fungus forming the rangy resting bodies appears not to have been described hitherto, it is presented here as a new species under a name having reference to its production of two kinds of conidia.

Dactylella heterospora sp. nov.

Mycelium effusum; hyphis hyalinis, septatis, plerumque 1.7–5 μ crassis, hic illic ex ramulis bilocularibus vulgo 12–25 μ longis et 2.5–3.5 μ crassis laqueos circulares 20–30 μ latos proferentibus qui in 3 cellulis arcuatis 15–25 μ longis medio 4–5.5 μ extremo 2.5–4 μ crassis consistunt; vermiculo nematoideo in laqueum apertum errato, tribus cellulis arcuatis abrupte se contrahentibus tumentibusque, ita animal captivum magnopere comprimentibus, mox id trucidentibus, integumentum ejus perforantibus, hyphas intus evolventibus quae carnem exhauriunt. Hyphae generis vulgaris fertiles hyalinae, erectae, simplices vel rarenter parvulum ramosae, plerumque 200–500 μ altae, basi 5–8 μ crassae, sursum leviter attenuatae, apice 2–4 μ crassae, conidia singula ferentes, quandoque recrescentes denique 1–2 alia conidia gerentes; his conidiis hyalinis, vulgo speciose ellipsoideis, fere rectis rarius curvatis, basi minute prominulis attamen abrupte truncatis, plerumque 35–47 μ (saepe circa 40 μ) longis, 13–20 (saepe circa 16.5 μ) crassis, biseptatis, loculo infimo 5–10 μ (saepe circa 7.3 μ) longo, loculo medio 21–30 (saepe circa 25.6 μ) longo, loculo summo 5–9.5 μ (saepe circa 7.1 μ) longo. Hyphae generis alterius fertiles hyalinae, saepius solos 15–25 μ longae, basi 2.5–4 μ crassae, sursum 1.5–2 μ crassae, apice singula conidia ferentes, denique identidem subter apicem repullulantes saepe 5–15 alia conidia deinceps gerentes, ita postea vulgo procumbentes vel ascendentes, irregulariter geniculatae, aliquot ramulis 1–10 μ longis instructae; conidiis hic abjunctis hyalinis, cylindraceis, utrimque rotundatis, plerumque curvatis vel allantoideis, 23–40 μ (saepe circa 31.3 μ) longis, 5.3–8 μ (saepe circa 6.8 μ) crassis, uniseptatis, loculo infero 7.5–17.5 μ (saepe circa 12.7 μ) longo, loculo supero 12–26 μ (saepe circa 18.6 μ) longo. Corpora perdurantia intra matricem orta, flavida, protoplasmatis valde guttulosi repleta, saepius intercalaria, modo simplicia, moniliformia, 100–250 μ longa, in 10–20 cellulis consistentia, modo ramosa denique ex 15–45 cellulis constantia; cellulis in medio corporis saepe 15–30 μ longis et 15–20 μ crassis, eis ad extremos angustioribus gradatim in hyphas mycelii transeuntibus.

Plectum parvum et alios vermiculos nematodeos capiens consumensque habitat in foliis Poae pratensis putrescentibus in Arlington, Virginia.

Mycelium spreading; vegetative hyphae hyaline, septate, 1.7 to 5 μ wide, often especially in presence of nematodes producing mostly underneath and in perpendicular positions approximately circular rings 20 to 30 μ in outside diameter, composed individually of 3 arcuate cells 15 to 25 μ long, 4 to 5.5 μ wide in the middle and 2.5 to 4 μ wide at the ends—the first and third of the cells being united to each other as well as to the distal end of a somewhat curved, 2-celled supporting stalk 12 to 25 μ long and 2.5 to 3.5 μ wide; following ensnarement of a nematode, the individual
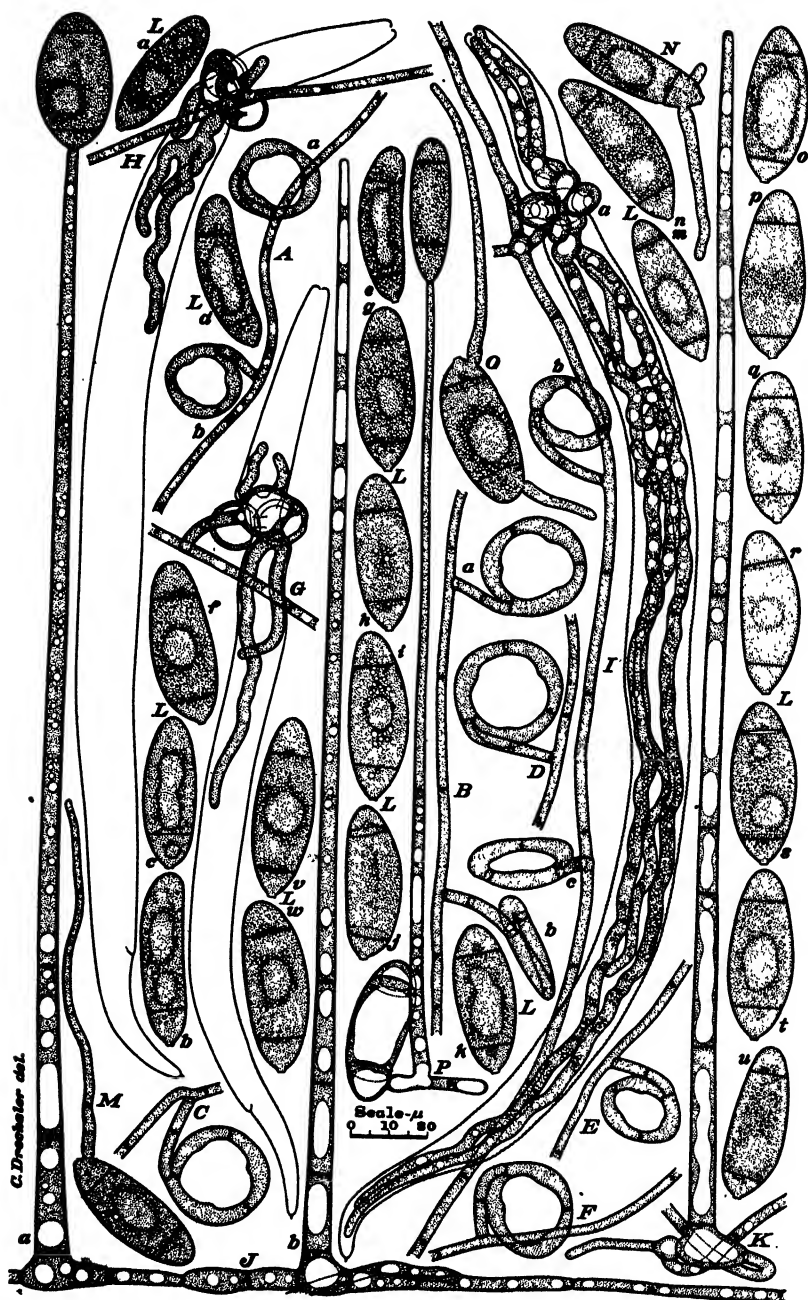
Fig. 1. *Dactylella heterospora* from nematode-infested cultures.

ring through inflation and contraction of the 3 arcuate cells constricting the animal to death or disabling it, then perforating the integument and extending lengthwise through the body assimilative hyphae that appropriate the fleshy contents. Conidiophores of the taller and more frequent type hyaline, erect, usually simple but occasionally branched, mostly 200 to 500 μ high, 5 to 8 μ wide at the base, tapering gradually upward, 2 to 4 μ wide at the apex, there bearing a single conidium, and sometimes, following repeated elongation, 1 or 2 additional conidia; the conidia thus produced being mostly handsomely prolate ellipsoidal, slightly protuberant at the abruptly truncate base, 35 to 47 μ (average 40 μ) long, 13 to 20 μ (average 16.5 μ) wide, divided by 2 cross-walls into 3 cells, the basal cell measuring 5 to 10 μ (average 7.3 μ) in length, the middle cell 21 to 30 μ (average 25.6 μ), and the apical cell 5 to 9.5 μ (average 7.1 μ). Conidiophores of the smaller type hyaline, often only 15 to 25 μ long, 2.5 to 4 μ wide at the base, 1.5 to 2 μ wide at the tip, after production of one conidium growing out repeatedly somewhat below the apices of successive spurs to abjoint often 5 to 15 additional conidia one after another, and thereby forming a strongly geniculate rachiform prolongation, often bearing several branches 1 to 10 μ long; the conidia abjointed here being hyaline, cylindrical with rounded ends, mostly curved and somewhat allantoid, 23 to 40 μ (average 31.3 μ) long, 5.3–8 μ (average 6.8 μ) wide, divided by a single cross-wall into a basal cell 7.5 to 17.5 μ (average 12.7 μ) long and a distal cell 12 to 26 μ (average 18.6 μ) long. Resting bodies regularly formed in the substratum, yellowish, filled with pronouncedly globuliferous protoplasm, most often intercalary, sometimes unbranched, moniliform, 100 to 250 μ long and composed of 10 to 20 cells, at other times branched and then often consisting of 15 to 45 cells; the median cells often 15 to 30 μ long and 15 to 20 μ wide, those at the ends narrower and gradually intergrading with contiguous unmodified mycelial segments.

Capturing and consuming *Plectus parvus* Bastian and various other nematodes it occurs in decaying leaves of *Poa pratensis* L. in Arlington, Va.

DACTYLARIA PULCHRA Linder

In an assortment of fungus cultures received from Dr. M. B. Linford late in 1937 and for the most part representing nematode-capturing hyphomycetes isolated by him from Hawaiian soils (8) was included a mucedinaceous form which he considered comparable biologically with my *Dactylella tenuis* (2: p. 538–539); for
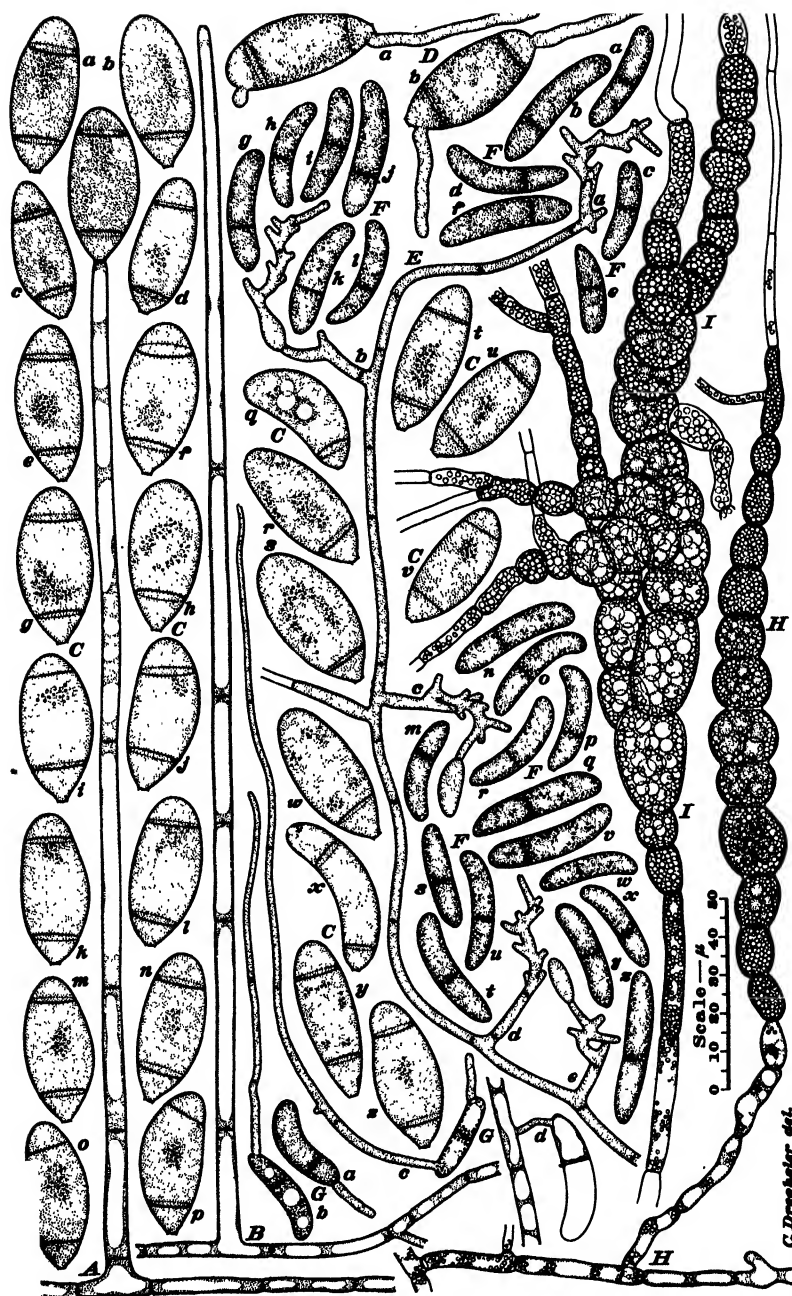
FIG. 2. *Dactylella heterospora* from pure Petri-plate cultures.

although it had come to light in his cultures under the same
conditions that favored development of aggressively predaceous
related forms, it had failed to show any predaceous behavior.
The erect conidiophores (FIG. 3, *A*, *a–c; B*, *a–c*) formed very
abundantly when this fungus was grown on Petri plates of maize-
meal agar agreed well with those described and figured by Linder
(7) in the original account of his *Dactylaria pulchra;* similarity
being evident in dimensions and in a close arrangement of
sterigmatic spurs along the irregularly rachiform tip.   Since the
conidia (FIG. 3, *C*, *a–q*) borne on the spurs likewise agreed in size,
as also in shape and septation, to Linder's description, the Ha-
waiian fungus was held referable to *Dactylaria pulchra*, though
owing to loss of all cultures derived from the material on which
this species was based an actual comparison could not be made.

What would seem to be the same fungus appeared early in 1938
in some Petri plate cultures that had been started from discolored
pieces of some lettuce (*Lactuca sativa* L.) seedlings found suc-
cumbing to damping-off in a greenhouse at the Bureau of Plant
Industry Station near Beltsville, Md.   The Maryland strain,
though in the end no less prolific than the Hawaiian strain, was
slower to begin sporulating.   Two weeks after planting its
conidial apparatus would, as a rule, hardly be visible to the
naked eye anywhere within the area occupied by its pale sub-
merged mycelium.   After two additional weeks, however, the
surface would usually be covered with a dense, somewhat pul-
verulent, almost crustose, markedly zonate, faintly yellowish
layer, composed of conidiophores and conidia in extraordinary
quantity, many of them present only as empty collapsed mem-
branes.   The predominance of conidia tapering almost equally
toward both ends (FIG. 3, *C*, *c, h, i*) over those with a thicker,
rather broadly rounded tip (FIG. 3, *C*, *a, b*) appeared often some-
what more pronounced in the Maryland strain than in the
Hawaiian strain.

All the tests hitherto made to uncover predaceous or parasitic
characteristics in the two strains have given negative results.
Sizable slabs well permeated with vigorous young mycelium of
the fungus were excised from maizemeal-agar plate cultures and
transferred to agar plate cultures infested with saprophilous eel-

worms of such genera as *Rhabditis*, *Plectus*, *Cephalobus*, *Acrobeloides*, *Diploscapter*, *Wilsonema* and *Bunonema*. No predaceous organs were ever formed in consequence of this procedure, and no eelworms were ever captured or parasitized. Nor were any of the various amoebae and testaceous rhizopods likewise present in the infested cultures ever observed undergoing attack by the fungus.

A DACTYLELLA BEARING SIX–SEPTATE FUSIFORM CONIDIA IN OPEN RACEMOSE ARRANGEMENT

Three weeks after a pinch of leaf mold taken from deciduous woods near Beltsville, Md., in February 1938, had been added to a maizemeal-agar culture thoroughly permeated with mycelium of *Pythium ultimum* Trow, delicate submerged hyphae bearing small globose knobs and non-constricting rings were found developing in a tract of substratum adjoining the deposit of forest refuse. As the adhesive knobs and more especially the non-constricting rings served effectively in the destruction of eelworms present in the culture, it was apparent that the hyphae obtained their nourishment mainly, if not solely, from the animals they consumed. In manner of operation, as also in morphology, the predaceous organs offered a close parallelism with those of *Dactylella lysipaga* Drechsl. (2: p. 499–504) and *Dactylaria candida* (Nees) Sacc. (2: p. 523–527). Reproductive apparatus likewise recalling these two species subsequently came to light in a sparse array of conidiophores that bore hyaline, septate, fusiform conidia singly or, at times, in groups of two or three. Rather unexpectedly, however, most of the conidia were found divided by six cross-walls—a number not hitherto observed in *D. lysipaga*, and only occasionally seen in *D. candida*. In order that the departure in septation might be studied better, the meager sporulating material was removed to facilitate aseptic transfer of the conidia to sterile maizemeal agar.

The fungus thus obtained free of alien organisms grows with moderate rapidity in pure culture to produce a pale colorless submerged mycelium of fairly close texture. After several days a few conidiophores may often be discovered under the microscope, though two or three weeks usually elapse before their increasing

numbers become visible to the naked eye as a delicate turf.   At
this later stage of development they frequently bear in rather
open racemose arrangement more than half a dozen conidia (FIG.
3, *D*), which, judging from the positional relationships of the
supporting spurs (FIG. 3, *E; F, a, b*), have obviously been formed
one after another on successive subapical prolongations.   The
six-septate condition most characteristic of the spores formed in
the original nematode-infested culture predominates also in those
produced in pure culture (FIG. 3, *G, a–n*).   Among 100 conidia
selected at random in a mount prepared from a maizemeal-agar
plate culture 16 days after planting, 3 were found divided by 7
septa, 55 by 6 septa, 35 by 5 septa, 6 by 4 septa, and 1 by 3 septa.
Measurements of the same 100 spores gave values for length,
expressed to the nearest integral number of microns, distributable
as follows: 29 μ, 1; 34 μ, 1; 35 μ, 1; 36 μ, 2; 37 μ, 1; 38 μ, 3; 39 μ,
3; 40 μ, 7; 41 μ, 6; 42 μ, 9; 43 μ, 11; 44 μ, 8; 45 μ, 7; 46 μ, 11; 47 μ,
10; 48 μ, 4; 49 μ, 5; 50 μ, 4; 51 μ, 4; 52 μ, 1; 54 μ, 1; and values for
width with the following distribution: 8 μ, 4; 9 μ, 55; 10 μ, 38;
11 μ, 3.   Most of the relatively few conidia that contained only
3 or 4 cross-walls were clavate in shape, while the much more
numerous and more perfectly developed spores that contained
5, 6, or 7 cross-walls were, as a rule, rather symmetrically
fusiform.

Sizable slabs of maizemeal agar newly permeated with my-
celium of the fungus have at various times been placed on agar
cultures well infested with eelworms.   In no instance, however,
has this procedure led to development of predaceous organs,
or provoked predaceous activity.   Perhaps the fungus is adapted
to capture animals only under rather special environal conditions,
which may have been lacking in all the tests hitherto made.   On
the other hand, it is about equally possible that the conidia
originally used in starting the pure culture had no connection
with the submerged hyphae bearing adhesive knobs and con-
stricting rings in proximity to them.

The fungus provides another example of the troublesome inter-
gradation between *Dactylella* and *Dactylaria* discussed in a pre-
vious paper (**3**: p. 467).   It is referred to the former genus partly
because on nematode-infested agar, where members of the pre-

daceous series commonly show the same sporulating habit as on their natural substrata, its production of plural conidia was hardly on a scale to permit capitate arrangement. To bring into relief one of the features setting it apart from several closely related forms, it is described under a specific name having reference to the frequent division of its conidia into seven segments.

Dactylella heptameres sp. nov.

Mycelium effusum; hyphis sterilibus hyalinis, septatis, ramosis, plerumque 1.5–3 μ crassis; hyphis fertilibus hyalinis, septatis, primum erectis, vulgo 50–150 μ altis, basi 2.5–3.5 μ crassis, sursum 1.5–2 μ crassis, apice uno conidio genito aliquando 1–10 μ subter apicem a latere identidem repullulantibus et ex incrementis saepius 5–35 μ longis 5–10 alia conidia deinceps gerentibus, itaque postea in parte supera plus minusve ramosis et aliquid degravatis; conidiis hyalinis, plerumque fusoideis, subinde clavatis, 3–7-septatis plerumque 6-septatis, 29–52 μ (saepe circa 44 μ) longis, 8–10.8 μ (saepe circa 9.3 μ) crassis.

Habitat in humo silvestri prope Beltsville, Maryland.

Mycelium spreading; vegetative hyphae colorless, septate, branched mostly 1.5 to 3 μ wide; conidiophores colorless, septate, at first erect, commonly 50 to 150 μ high, 2.5 to 3.5 μ wide at the base, 1.5 to 2 μ wide at the tip, sometimes after producing one conidium repeatedly growing out 1 to 10 μ below the apex to produce 5 to 10 additional conidia on the apices of successive prolongations mostly 5 to 35 μ in length, thereby often becoming somewhat branched and weighed down distally; conidia colorless, mostly spindle-shaped, occasionally club-shaped, divided by 3 to 7 cross-walls, most often divided by 6 cross-walls, 29 to 52 μ (average 44 μ) long, 8 to 10.8 μ (average 9.3 μ) wide.

Occurring in leaf mold near Beltsville, Md.

A DACTYLELLA BEARING SEVEN-SEPTATE CONIDIA IN
OPEN ARRANGEMENT

Fifteen days after some pinches of leaf mold from a supply collected in deciduous woods near Beltsville, Md., in January 1938, were planted on a maizemeal-agar culture newly permeated with mycelium of *Pythium Butleri* Subr., slender erect unbranched conidiophores (FIG. 3, *II, a, b*) were found scattered sparsely in a tract of substratum adjoining one of the deposits of decaying material. Each of these conidiophores produced at its tip only a single conidium, though frequently after falling over on the agar medium, now abundantly infested with nematodes, amoebae,

and bacteria, it continued to serve a reproductive function by giving rise from one of its proximal segments to a second conidiophore; the same process being repeated, in some instances, half a dozen times. The conidia here produced (FIG. 3, *I, a–k*) were clavate in shape and contained usually 7 cross-walls. They varied mostly between 42 μ and 60 μ in length, and between 7.6 μ and 9.6 μ in width; measurements of the two dimensions gave average values of 52.7 μ and 8.6 μ, respectively.

By aseptic removal of the conidia from their supporting hyphae, the fungus was readily obtained free of alien microorganisms. Growing in pure culture on maizemeal agar it ordinarily advances more than 2 mm. a day to produce a pale mycelium of rather close texture. From the superficial hyphae conidiophores are sent up, which like the conidiophores of *Dactylella heptameres* formed in pure culture, eventually often produce 5 to 10 conidia in loose arrangement (FIG. 3, *J*). The first conidium is borne commonly at a height between 75 μ and 100 μ; the others being formed singly on branches that sometimes come directly from the main axis (FIG. 3, *K*), but more often are put forth one after another in a zigzag series (FIG. 3, *L–N*). When sporulation takes place abundantly in pure culture the conidia (FIG. 3, *O, a–t*) have been found to vary in length mostly between 36 μ and 53 μ, and in width between 6.7 μ and 9 μ; measurements of the two dimensions yielding averages of 44.5 μ and 8.1 μ respectively. The 7-septate condition predominates here hardly less strongly than in the original nematode-infested culture. Conidia with 8, 9, or 10 cross-walls are formed in relatively small numbers.

The fungus appears to differ rather markedly from the several related species that have been described as producing clavate spores. Its conidia, on the one hand, are decisively wider than those of *Monacrosporium subtile*, which according to Oudemans' (10) account measure 45 to 70 μ in length and 5 to 7 μ in width; while, on the other hand, they are decisively narrower than the massive spores of *Dactylella minuta* that were set forth by Grove (5) as ranging in length from 60 to 70 μ, and in width from 14 to 15 μ. When comparison is extended to *M. sarcopodioides* (Harz) Berl. et Vogl. (11: p. 552) whose clavate spores, 35 to 38 μ long, are divided by only 3 to 5 cross-walls, a pronounced dif-
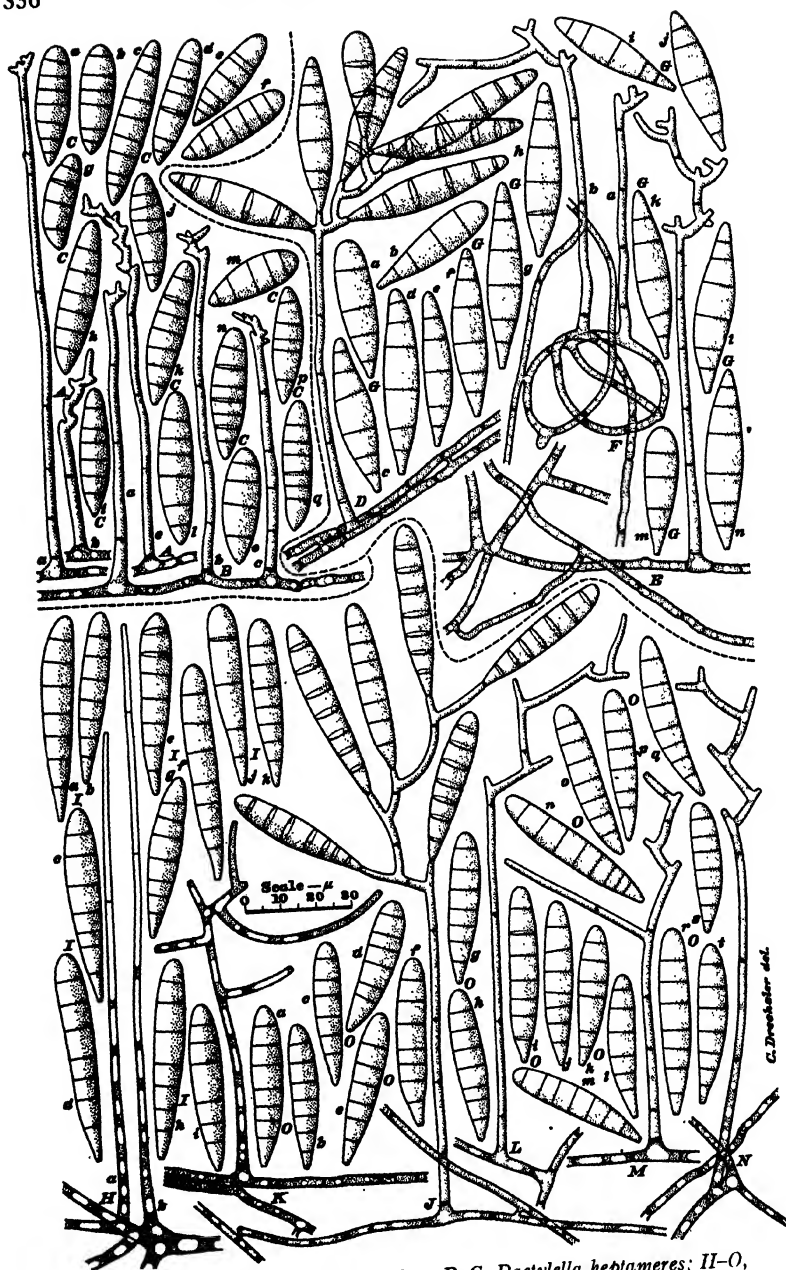
FIG. 3.   A–C, *Dactylaria pulchra;* D–G, *Dactylella heptameres;* H–O,
Dactylella rhopalota.

ference in conidial septation comes to light. The fungus mani-
festly is not to be identified with any form producing mostly
spindle-shaped conidia. It is accordingly described as a new
species under a name meaning "club-shaped."

Dactylella rhopalota sp. nov.

Mycelium effusum; hyphis sterilibus hyalinis, septatis, ramosis, plerumque
1–3 μ crassis; hyphis fertilibus hyalinis, septatis, primum erectis, plerumque
50–200 μ altis, basi 2.5–4 μ crassis, sursum attenuatis, apice 1–2 μ crassis, uno
conidio genito saepe procidentibus denique hypham fertilem ordinis secundi
prope basin proferentibus, saepe stantibus et 1–20 μ subter apicem a latere
identidem repullulantibus et ex incrementis vulgo 10–50 μ longis 5–10 alia
conidia gerentibus itaque postea in parte supera ramosis et aliquid degravatis;
conidiis hyalinis, plerumque clavatis subinde paene cylindraceis, 3–10-septatis
plerumque 7-septatis, 36–60 μ longis, 6.7–9.6 μ crassis.

Habitat in humo silvestri prope Beltsville, Maryland.

Mycelium spreading; vegetative hyphae colorless, septate,
branched, mostly 1 to 3 μ wide; conidiophores colorless, septate,
at first erect, mostly 50 to 200 μ high, 2.5 to 4 μ wide at the base,
tapering upward, 1 to 2 μ wide at the tip, after forming a single
terminal conidium sometimes falling over on the substratum and
giving rise near the base to a second conidiophore, sometimes
remaining standing and repeatedly growing out 1 to 20 μ below
the apex to produce 5 to 10 additional conidia on the apices of
branches or of successive prolongations mostly 10 to 50 μ in
length, thereby becoming somewhat ramified and weighed down
distally; conidia colorless, mostly clavate, occasionally more
nearly cylindrical, 36 to 60 μ long, 6.7 to 9.6 μ wide.

Occurring in leaf mold near Beltsville, Md.

A DACTYLELLA BEARING TEN-SEPTATE CONIDIA IN LOOSE
RACEMOSE ARRANGEMENT

A very prolific species of *Dactylella* has repeatedly made its
appearance in maizemeal-agar plate cultures which after being
permeated with *Pythium* mycelium had been further planted with
small quantities of partly decayed tomato leaves collected in
winter from greenhouse beds. The filaments of its sparse my-
celium have never been observed attacking any of the various
nematodes and protozoans that multiplied in the cultures after
the decaying material was added.

The fungus shows greater tolerance toward bacteria than most
other members of the predaceous series of hyphomycetes. Even

in the heavily contaminated original cultures its conidiophores often grew so luxuriantly that here and there groups of them became visible to the naked eye as minute white aerial tufts. When conidia were transferred from these tufts to sterile maize-meal agar, pure cultures were promptly obtained; the mycelium extended in the absence of alien organisms being pale, colorless, and of close texture.   In Petri plate cultures conidiophores are ordinarily sent up within a few days and continue to develop usually for about a month; so that eventually they often make up a felty layer, which sometimes is white, and at other times has a faint pinkish or yellowish coloration.   The extraordinarily copious sporulation revealed in such a layer is achieved in large part through repeated branching and subapical prolongation of the individual conidiophore, which as a result often comes to bear more than a score of conidia (FIG. 4, *A*).   Owing to pro-nounced irregularity in the manner of branching (FIG. 4, *B–G*) the arrangement of the conidia can be designated only rather ap-proximately as loosely racemose.

By far the greater proportion of conidia (FIG. 4, *H–Z*) are spindle-shaped, and show little difference in conformation be-tween their proximal and distal ends.   A clavate shape, much as in *Dactylella heptameres*, often distinguishes the shorter, under-sized specimens (FIG. 4, *H, M, Q, X*), which contain mostly from 3 to 7 cross-walls.   In the fusiform specimens, where the number of cross-walls varies from 7 to 13, the 10-septate condition pre-dominates strongly.   Clavate and fusiform specimens were taken indiscriminately in selecting at random the 100 conidia whose measurements were used in preparing the statement on conidial dimensions given in the diagnosis.   The 100 measurements for length gave values distributable in classes as follows: 26–30 μ, 3; 31–35 μ, 1; 36–40 μ, 1; 41–45 μ, 2; 46–50 μ, 1; 51–55 μ, 5; 56–60 μ, 12; 61–65 μ, 43; 66–70 μ, 25; 71–75 μ, 6; 76–80 μ, 1; while the measurements for width gave values, expressed to the nearest integral number of microns, distributable thus: 7 μ, 4; 8 μ, 18; 9 μ, 61; 10 μ, 17

Although the fungus recalls *Monacrosporium oxysporum* Sacc. et March., described from excrement of caterpillars in Brussels (9   its conidia are not only considerably shorter than those of
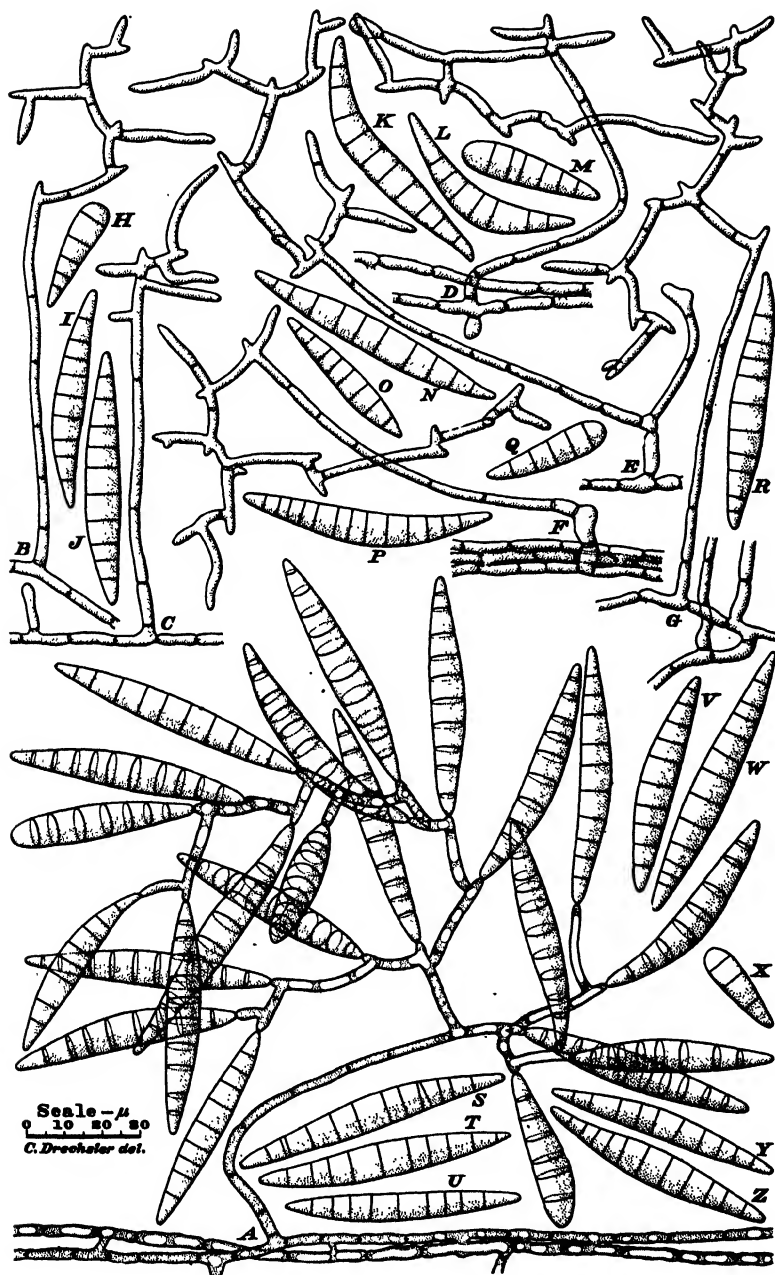
Fig. 4.   *Dactylella atractoides.*

the Belgian species but differ further in that they are rounded at both ends rather than acutely pointed. Much greater similarity in conidial morphology is evident when comparison is made with *Dactylella minuta* var. *fusiformis* Grove (6), and the likelihood of identity with this variety cannot readily be dismissed. However as my fungus appears wholly alien to typical *D. minuta*, which produces decidedly wider conidia of clavate shape, I am describing it as a separate species, under an epithet different from the varietal name used by Grove, but of similar meaning.

Dactylella atractoides sp. nov.

Mycelium effusum; hyphis sterilibus hyalinis, septatis, ramosis, plerumque 1–4 μ crassis; hyphis fertilibus hyalinis, septatis, primum erectis, basi 3–5 μ crassis, sursum 2.5–3 μ crassis, uno conidio genito 2–20 μ subter apicem a latere, identidem repullulantibus et ex incrementis 5–40 μ longis 5–25 alia conidia gerentibus itaque postea usque 300 μ longis aliquantum ramosis degravatisque; conidiis hyalinis, plerumque fusiformibus, subinde clavatis, rectis vel nonnihil curvatis, 3–13-septatis (septis saepius denis), 26–76 μ (saepius circa 62 μ) longis, 7.2–10.2 μ (saepius circa 8.8 μ) crassis.

Habitat in foliis Lycopersici esculenti putrescentibus prope Beltsville, Maryland.

Mycelium spreading; vegetative hyphae hyaline, septate, branched, mostly 1–4 μ wide; conidiophores hyaline, septate, at first erect, 3 to 5 μ wide at the base, 2.5 to 3 μ wide above, after attaining a length frequently of 100 to 125 μ and producing a terminal conidium repeatedly growing out laterally 2 to 20 μ below the apex to produce 5 to 25 additional conidia on the apices of branches or prolongations often 5 to 40 μ in length, thereby becoming rather extensively ramified; conidia colorless, mostly spindle-shaped, occasionally club-shaped, straight or somewhat curved, divided by 3 to 13 cross-walls, most often divided by 10 cross-walls, measuring 26 to 76 μ (average 62 μ) in length and 7.2 to 10.2 μ (average 8.8 μ) in width.

Occurring in decaying leaves of *Lycopersicon esculentum* Mill. near Beltsville, Md.

DIVISION OF FRUIT AND VEGETABLES CROPS AND DISEASES,
BUREAU OF PLANT INDUSTRY STATION,
BELTSVILLE, MARYLAND

LITERATURE CITED

1. **Buller, A. H. R.** Researches on fungi. vol. 5. 416 pp. 1933.
2. **Drechsler, C.** Some hyphomycetes that prey on free-living terricolous nematodes. Mycologia 29: 447–552. 1937.

3. ——. Three new hyphomycetes preying on free-living terricolous nematodes. Mycologia **32**: 448–470. 1940.
4. ——. Some hyphomycetes parasitic on free-living terricolous nematodes. Phytopathology **31**: 773–802. 1941.
5. **Grove, W. B.** New or noteworthy fungi. Jour. Bot. **22**: 129–136, 195–201. 1884.
6. ——. New or noteworthy fungi: Part III. Jour. Bot. **24**: 129–137, 197–206. 1886.
7. **Linder, D. H.** North American Hyphomycetes II. New species and a new genus. Mycologia **26**: 436–440. 1934.
8. **Linford, M. B.** Stimulated activity of natural enemies of nematodes. Science **85**: 123–124. 1937.
9. **Marchal, É.** Champignons coprophiles de Belgique. Bull. Soc. Roy. Bot. Belgique **24**: 57–77. 1885.
10. **Oudemans, C. A. J. A.** Aanwinsten voor de flora mycologica van Nederland, IX en X. Nederl. Kruidk. Arch. II. **4**: 203–278. 1885.
11. **Saccardo, P. A.** Sylloge fungorum. vol. 10. 1892.

EXPLANATION OF FIGURES

FIG. 1. *Dactylella heterospora* as found developing on nematode-infested maizemeal-agar plate cultures; drawn to a uniform magnification with the aid of a camera lucida, and reproduced at an enlargement of 500 diameters. *A*, *B*, Portions of hyphae, each bearing two open predaceous rings, *a* and *b*. *C–F*, Portions of hyphae, each bearing an open predaceous ring. *G*, *H*, Portions of hyphae, on each of which is borne a ring that after closing on a specimen of *Plectus parvus* has intruded several growing assimilative filaments into the fleshy interior of the captive. *I*, Portion of hypha bearing three predaceous rings, *a*, *b*, and *c*, of which *b* and *c* are open; the ring *a*, after closing on a specimen of *P. parvus*, has extended haustorial filaments lengthwise throughout the animal. *J*, Portion of prostrate hypha from which two tall conidiophores have originated; one of them, *a*, shown with the single large conidium attached; the other, *b*, shown in a denuded state. *K*, Small portion of mycelium with a denuded tall conidiophore. *L*, Random assortment of large conidia, *a–w*, showing variations in size, shape, and septation. *M*, Conidium of large type germinating by production of a single germ tube. *N*, *O*, Large conidia germinating by production of two germ tubes. *P*, Conidium of large type that has put forth a germ conidiophore bearing a secondary conidium.

FIG. 2. *Dactylella heterospora* as found developing in pure culture on maizemeal-agar plates; drawn to a uniform magnification with the aid of a camera lucida, and reproduced at an enlargement of 500 diameters. *A*, Portion of a prostrate hypha with a tall conidiophore to which is attached the single large conidium produced on it. *B*, Portion of a prostrate hypha with a tall conidiophore in denuded state. *C*, Random assortment of large conidia, *a–z*, showing variations in size, shape, and septation. *D*, Two large conidia, *a* and *b*, germinating by production of a germ tube from each end cell. *E*, Prostrate filament that has produced smaller conidia on the apices of rachiform prolongations extended from its tip, *a*, and from four lateral branches, *b–e*. *F*, Random assortment of conidia of the smaller type, *a–z*, showing variations

in size, shape, and septation. *H*, Unbranched resting body. *I*, Branched resting body.

FIG. 3.   Drawn to a uniform magnification with the aid of a camera lucida; × 500 throughout.

A -C, Dactylaria pulchra: A, Portions of procumbent hypha, *a–c*, each with a denuded conidiophore.   *B*, Portion of procumbent hypha with three erect conidiophores, *a–c*, in denuded condition.   *C*, Random assortment of conidia, *a–q*, showing variations in size, shape, and septation.

D–G, Dactylella heptameres as found developing in pure culture on Petri plates of maizemeal agar sixteen days after planting: *D*, Portion of mycelium with a conidiophore bearing seven conidia.   *E*, Portion of mycelium with a denuded conidiophore on which ten conidia were produced.   *F*, Portion of mycelium with two conidiophores, *a* and *b*, which produced, respectively, three and six conidia.   *G*, Detached conidia, *a–n*, showing variations in size, shape, and septation.

H, I, Dactylella rhopalota as found developing in a maizemeal-agar plate culture infested with nematodes, amoebae, and bacteria: *H*, Portion of mycelium with two denuded conidiophores, *a* and *b*, on each of which a single conidium was produced.   *I*, Detached conidia, *a–k*, showing variations in size, shape, and septation.

J–O, Dactylella rhopalota as found developing in pure culture on Petri plates of maizemeal agar: *J*, Portion of mycelium with a conidiophore bearing six conidia.   *K–N*, Portions of mycelium, each with a denuded conidiophore; in *K*, *L* and *N* six conidia were abjointed, in *M* five were abjointed.   *O*, Detached conidia, *a–t*, showing variations in size, shape, and septation.

FIG. 4.   *Dactylella atractoides* as found developing in pure culture on Petri plates of maizemeal agar; drawn to a uniform magnification with the aid of a camera lucida, and reproduced at an enlargement of 500 diameters.   *A*, Portion of mycelium with a conidiophore bearing twenty-two conidia.   *B–G*, Portions of mycelium, each with a denuded branching conidiophore; presumably nine conidia were abjointed in *B*, seven in *C*, nine in *D*, fourteen in *E*, eighteen in *F*, and eighteen in *G*.   *H–Z*, Detached conidia showing variations in size, shape, and septation.

NOTES ON THE MYCETOZOA—VII

ROBERT HAGELSTEIN

The restrictions of the war efforts curbed somewhat our collecting activities during the season of 1942. A few days were spent in Schoharie County, New York, where, among other forms, the rare *Diderma Sauteri* (Rost.) Macbr. was found. A week's stay in Pike County, Pennsylvania, during the latter part of August, with 30 hours of actual field work, yielded 96 species in 30 genera. In Pike County we stop at Shohola Falls in a small inn kept by Mr. and Mrs. Flanagan. The beautiful falls and gorge of the Shohola Creek are within a few minutes walk from there. The house is on a mountain-side at an altitude of 1248 feet, surrounded by the deep forest, and the nearest other house is a mile away. Some of our best finds have been made around that inn in short rambles before breakfast and after supper. *Diderma Sauteri* was again found about a hundred feet below the house on a mossy rock in a moist area. Mr. Rispaud made extensive collections at Mitchell Field, Long Island, where he is employed, and among them was *Trichia lutescens* Lister.

One of the most interesting and instructive collections we have ever made was at Jericho, Long Island, New York. Here, on a private estate, workmen had cut logs from the adjoining forest and stacked them for use as fire-wood during the approaching winter. Mr. Rispaud visited the pile in early September, and among other forms, found a fine development of *Perichaena chrysosperma* on the top bark of one of the logs which appeared to be a species of elm. On examining it at home, and after study, we found the following other forms of *Perichaena* present, all jumbled together and intermingled, sometimes sporangia of one species fruiting on those of another, and all in splendid condition: *P. corticalis*, *P. corticalis* var. *liceoides*, *P. depressa*, *P. minor*, *P. minor* var. *pardina*, and the phase of *P. depressa* regarded by Macbride as *P. quadrata*. With the plasmodia of nearly every form of the genus *Perichaena* known from North America in one

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log, it may well be reasoned that some of them are not species, but more likely, intermediates or hybrids. Some of the forms mentioned are extremely rare. They are discussed later in this paper.

ARCYRIA GLOBOSA Schw. It is significant that this species was found twice on ground leaves of the chestnut oak (*Quercus Prinus* L.) in Pike County, Pennsylvania, during August. We have never found it before in this general area, although there are many large, dead chestnut trees still standing and also young saplings. The species was common and abundant on chestnut burs before the destruction of the trees by the blight, and possibly it has adapted itself to another habitat. N. Y. B. G. Nos. *2330, 2342.*

CERATIOMYXA FRUTICULOSA (Muell.) Macbr. The generally recognized variety *porioides* of this species is not a distinct variety, but merely a phase developing from the same plasmodium as the typical form, only, under conditions of greater moisture. This was clearly observed during our visit to a large pile of sawdust in Pike County, Pennsylvania, in August. The last of the frequent, heavy, preceding rains had fallen three days before our visit, and the sawdust was still so wet below that our feet sank deeply into it. The dryer layer on top was covered with many fruitings of a number of species, among which were numerous developments of *C. fruticulosa*, all of which more or less, showed the honey-comb structure and free sporophores with transition from one to the other in the same colony. Unquestionably, this proceeds when moisture conditions change during the time of the formation of the fruiting bodies. The fragile character of the habitat made it impossible to transport much of the material, and this little was badly broken when we reached home. In the past, we have found several specimens on wood.

COMATRICHA RISPAUDII Hagelstein. Collected three times in different sections of Pike County, Pennsylvania, in August. N. Y. B. G. Nos. *2302, 2360, 2365.*

CRATERIUM MINUTUM (Leers) Fries. This species occasionally forms long, cylindrical sporangia with white, convex lids. We have found the phase several times, and another fine collection was made by Robert H. Rispaud, on the leaf pile mentioned under *Physarum superbum.* This variety bears the same relation to the

typical form of *C. minutum* that var. *cylindricum* does to the typical form of *Craterium leucocephalum* (Pers.) Ditm.   N. Y. B. G. No. *2152*.

DIANEMA CORTICATUM Lister.   The form seems to be quite common on dead pine in Pike County, Pennsylvania.   It was found again in August, and like former collections from there, it appears to have no capillitium.   N. Y. B. G. No. *2346*.

DIDERMA ANTARCTICA (Speg.) Sturg. Mycologia **8**: 37.   1916. Dr. Sturgis, in the paper cited, described specimens gathered by Prof. Roland Thaxter at Punta Arenas, Chile, believing they conformed to the description of *Licea antarctica* Speg. Bol. Acad. Nat. Cienc. Cord. **11**: 56.   1887.   A translation of Spegazzini's description appeared in Lister, Mycetozoa 151, 1894, and suggests as Lister says, a form of the genus *Perichaena*.   Apparently, the type specimen of Spegazzini was not examined as it was unavailable, and all later descriptions and figures of *D. antarctica* are based on Thaxter's specimens and Sturgis' conception.

The Thaxter specimens used by Sturgis are now in the Herbarium of the New York Botanical Garden.   The sporangia resemble those of *Diderma asteroides* Lister.   In many of the sporangia there are no columellae at all, merely thickenings of the sporangial floors with lime.   In others, where a columella is present, it consists of an irregular mass of lime composed of smaller irregular masses, and occasionally there are spike-like, calcareous processes extending from the columella or from the wall, to which processes the capillitium is attached.   The capillitium is very irregular and differs in almost every sporangium.   It consists of rigid threads radiating from wide expansions, the threads usually broad and irregular along the sides.   Sometimes the expansions are absent, or there are but few threads attached to the base, or to the columella and wall.   The threads are often attached to the processes or lumps of the columella.   The spores when fully swollen do not have any ridges, and are like the spores of *D. asteroides*, but if imperfectly swollen, show the lines of the earlier contraction brought about by long and thorough drying.   There is no constancy whatever throughout the colonies, and they are surely abnormal forms of some species of the genus *Diderma*, probably *D. asteroides*, as I regard them.   I have already noted

similar forms in *Diderma spumarioides* (Mycologia 33: 301.   1941)
and in *Diderma simplex* (Mycologia **34**: 256.   1942).   Plunkett
(Pub. Univ. Calif. Biol. Sc. 1: 41.   1934) reports as *D. antarctica*
two collections from California, and mentions differences between
them and published descriptions and figures of *D. antarctica*.
There appear to be no other records.   N. Y. B. G. Nos. *12486,
12487*.

DIDERMA SAUTERI (Rost.) Macbr.   This extremely rare species
was found in fair abundance at Shohola Falls, Pike County,
Pennsylvania, in August, associated with *Lamproderma colum-
binum* (Pers.) Rost.; and a small gathering was made by Robert
H. Rispaud, the young son of Mr. Rispaud Sr., at Middleburg,
Schoharie County, New York, in July.   N. Y. B. G. Nos. *2344,
2368.*

DIDYMIUM STURGISII Hagelstein.   The species was observed
on the bark of many ash trees in Pike and Wayne Counties,
Pennsylvania, during August, and widely separated by miles.
The developments were on standing trees, or such as had fallen
with one or both ends elevated above the ground.   Countless
small plasmodiocarps extended for many feet around the dead
trunks.   The form was also collected for the first time on Long
Island, New York, on dead poplar bark, in August.   N. Y. B. G.
Nos. *2148, 2351, 2355, 2356.*

ELAEOMYXA MIYAZAKIENSIS (Emoto) Hagelstein, Mycologia **34**:
593.   1942.   The species was described originally by Emoto as
Diachea miyazakiensis (Proc. Imp. Acad. Tokyo 11: 444.   1935)
on material found in Japan.   It has been collected repeatedly by
Mr. Eli Davis and Mr. W. D. Sutton near London, Ontario, and
may occur elsewhere in North America.   As Emoto's German
description is not readily obtainable, a translation is appropriate.

Plasmodium not observed; total height 1 to 1.5 mm.; sporangia
gregarious, cone-shaped, stalked, blue or irridescent violet; spor-
angial wall membranous, transparent, sometimes with pale orange
oil granules; stalk cylindrical, somewhat thicker in the middle,
brownish black, 0.1 to 1 mm. long, about 0.05 mm. diam.; hypo-
thallus not developed; columella reaching to half the height of the
sporangium, violet-brownish black, dividing into branches, with-
out lime; capillitium springing from the columella, of branching
and anastomosing, dark violet-brown threads, colorless at the

tips, and having at the axils oil bearing nodules, 5–30 μ diam., pale orange or pale orange-red, containing many granules; spores globose, dark violet-brown, warted, 7–10 μ diam.

Emoto used the German word for oil to explain the material in the sporangial wall and capillitium. *Elaeomyxa cerifera* (G. Lister) Hagelstein has a similar substance in the stalk, and Miss Lister considered this as wax. Emoto may have used the word oil as synonymous with wax. In the Ontario specimens the substance is solid at ordinary temperatures. The thickness of the stalk, 0.05 mm., as given by Emoto does not agree with his accompanying figure. This is probably an error and should be about 0.25 mm. which would coincide with his figure and the stalks of the Ontario material.

FULIGO INTERMEDIA Macbr. In prior Notes (Mycologia **29**: 398–400. 1937, and **33**: 304–305. 1941), I referred to numerous aethalia of a *Fuligo* found at Middleburg, Schoharie County, New York, and regarded therein as *Fuligo septica* (L.) Weber.

At Mitchell Field, Long Island, New York, there were in August many large, poplar logs which had been cut somewhere else on Long Island and removed to the Field. The logs were on open ground and exposed to the sun. On these logs appeared at that time, and several times thereafter at intervals, hundreds of aethalia of the same form reported from Middleburg, identical in appearance and characters with the earlier developments, and with a layer of perfected sporangia on the outside instead of a cortex. Also, there were many small clusters of heaped, confluent, irregularly shaped sporangia, often 1 mm. or less across, and occasionally single sporangia, sessile or attached to stalk-like strands of the hypothallus. In the clusters there is no clear evidence of an aethalioid formation. All forms were associated with many aethalia of *Mucilago spongiosa* (Leyss.) Morg. var. *solida*.

Judged by the constancy of this large mass of material, I am convinced the form deserves specific rank. Specimens collected by Prof. Bethel in Colorado are at hand, as well as others from California, Florida and Kansas. *F. intermedia* is based on similar collections made by Bethel, and the New York material is the same. The form was not correctly described by Macbride, so a description based on the New York material follows.

Aethalia pulvinate or depressed, sometimes confluent or annulate, dirty white, greenish white, or ochraceous, 1 to 6 cm. across, usually forming many aethalia from a single plasmodium, occasionally forming small clusters of heaped sporangia. Cortex absent. The inner structure of the aethalium is like that of *Fuligo septica*. The twisted and confluent sporangia of the outer layer are well developed with walls, capillitia and spores. Sporangial wall membranous, colorless, densely covered with a compacted shell of white lime-granules, sometimes separable. Capillitium of short threads connecting large, white, branching lime-knots, united in a dense mass at the center and *Badhamia*-like. Spores purplish brown, globose, 9–12 μ diam., with occasionally a few ovoid or ellipsoid spores, distinctly spinulose.

FULIGO SEPTICA (L.) Weber. The wet season produced many small, solitary aethalia of a *Fuligo* on leaves in wooded regions of Pike County, Pennsylvania, and Long Island, New York. These usually are small, less than 25 mm. across, although some years back we found one more than 30 cm. in size. They all have a labyrinthine structure, similar to the small rosettes of *Physarum gyrosum* Rost., but never accompanied by the latter. They have the small, pale spores of both species, and the lime-knots are fusiform and transversely placed. Usually the aethalia are gray from the absence of lime on the surface, but occasionally lime is present, and on one occasion we found an aethalium with a firm cortex. These forms have been erroneously regarded as phases of *F. cinerea* or plasmodiocarps of *P. gyrosum*, and, while they appear to be intermediate with the latter species, they have the aethalioid form of fructification, and nearer to *F. septica*.

LEPIDODERMA CARESTIANUM Rost. The three members of the genus *Lepidoderma* are characterized by the presence of vitreous discs or scales in pockets of the sporangial wall which are easily dislodged. This is a constant character, and must not be confused with the occasional presence in some species of *Physarum* and *Diderma* where the lime was originally deposited as granules, and by subsequent action of water and drying altered to similar discs or plates. *L. tigrinum* is well marked and easily recognized. The two other species, *L. Carestianum* and *L. Chailletii*, are not so clearly understood in North America because of the scarcity of authentic specimens. In Europe the forms are more abundant,

and are seen to represent the extremes of a long range of variation. In *L. Carestianum* the fructification is more or less plasmodiocarpous, and in typical examples the plasmodiocarps are flattened and effused. Such forms have been found in the mountains of New Hampshire and agree perfectly with the type material of *Reticularia Carestiana* Rabenh. (N. Y. B. G. No. *6816*). The sporangial wall in *L. Carestianum* is brown or purplish, and the capillitium has coarse threads which often have dark, bead-like warts. Var. *granuliferum* (N. Y. B. G. No. *5570*, type material), although regarded by some students as a distinct species, is hardly more than a variety of *L. Carestianum*. In the variety, there are expansions in the capillitium containing lime-granules. Similar lime-knots are seen occasionally in some species of the genus *Diderma*. The spores in the type specimen of var. *granuliferum*, collected by Harkness in California, are irregular and unusually large, 20–30 μ diam., a clear indication of abnormality. A collection made by Garrett in Utah (N. Y. B. G. No. *11223*) has more representative lime-knots, and the spores are 14–16 μ diam. The size of the spores in this group varies so much that it is of little significance in classification. Macbride and Martin (Myxomycetes 142. 1934) say that Harkness No. *35*, from Utah, in the Ellis collection, N. Y. Bot. Gard., belongs with *L. granuliferum* (Phill.) R. E. Fries, as they prefer to call the variety. The particular specimen is one of two mentioned on the following page (143) under *L. Carestianum*, as representing *Amaurochaete minor* Sacc. & Ellis. They are typical *L. Carestianum* and have no lime in the capillitium. Macbride and Martin probably intended to refer to Harkness No. *23/29* from California, which is type material of *Didymium granuliferum* Phill., and regarded as var. *granuliferum*.

L. Chailletii Rost. is distinguished from *L. Carestianum* by the more frequent habit of forming distinct sporangia, often with stalks arising from a hypothallus; the paler colored sporangial walls; and the more slender and smoother threads of the capillitium.

MARGARITA METALLICA (Berk. & Br.) Lister. The species is rare in eastern North America, and was found for the first time in Pike County, Pennsylvania, in August. N. Y. B. G. No. *2306*.

PERICHAENA CHRYSOSPERMA (Currey) Lister.   On the bark of the log previously mentioned from Jericho, Long Island, were the finest developments of this species that we have ever found. They were beautifully matured, and consisted of large, dark brown, straight, curved or ring-shaped plasmodiocarps, with many subglobose to globose sporangia, often with little granular matter on the walls, and showing distinct papillae like on the wall of *Perichaena vermicularis* (Schw.) Rost.   The globose sporangia range from 0.2 to 0.5 mm. diam., and the dehiscence is either irregular or by areolae.   A few of the sporangia and plasmodiocarps have large dark warts, composed of granular refuse matter, on the outside like in *Perichaena minor* var. *pardina*.   The capillitium in all these forms of *P. chrysosperma* is similar, except that the more robust ones have the spines on the capillitium a little longer.   The threads of the capillitium are about 2.5 μ thick, irregularly constricted, and with numerous curved spines about 3 μ long.

Attention is called to an error in the Lister Monograph in the note following the description of *P. vermicularis*.   Therein it says that the distinct papillose wall is a character by which the species is distinguished from all others of the genus *Perichaena*.   The wall of *P. chrysosperma* is also papillose, and this is stated in the description of the species in the 3rd. edition of the Lister Monograph.   N. Y. B. G. Nos. *2160–2164*.

PERICHAENA CORTICALIS (Batsch) Rost.   On the bark of the log from Jericho, Long Island, were many sporangia of this species, associated with *P. chrysosperma* and other forms of the genus.   The sporangia are of the phase where the dehiscence is horizontal with a well-defined, highly elevated, convex lid.   Some of the sporangia are very small, 0.2 mm. diam., or even less.   The capillitium is abundant, branched and netted, with threads 2 μ thick, which are fairly regular without constrictions, but with many minute spines.   The spores are about 10 μ diam.   Forms like these are close to *P. depressa* Lib., and probably intermediate therewith, but accepting the shape of the sporangia as the more important character, rather than the capillitium and spores, I have always regarded them as nearer *P. corticalis*.   Developments with such sporangia, and associated with undoubted *P. depressa*

are not rare, and in the present collection a few sporangia of
P. depressa were observed.

Widely scattered among all the forms of *Perichaena* present
were many solitary sporangia of *P. corticalis* var. *liceoides* (Rost.)
Lister. These are sessile, globose, 0.2 to 0.5 mm. diam., shining
iridescent brown, blue or purple, and with irregular dehiscence.
The sporangial wall is thin, membranous, smooth, translucent,
pale yellowish, and with scanty refuse matter or none. The
capillitium is scanty, with little branching, of nearly smooth,
tubular threads, 1.5 μ diam. The spores are olivaceous in mass,
pale yellow by transmitted light, faintly warted, 10–11 μ diam.
N. Y. B. G. Nos. *2167, 2168*.

PERICHAENA MINOR (G. Lister) Hagelstein, Mycologia **35**: 130.
1943. This species and var. *pardina* (Minakata) Hagelstein, l. c.
were originally described by Miss Lister as having faint or incon-
spicuous spiral bands on the capillitium. The variety differs
from the typical form in having dark, prominent warts, composed ·
of granular refuse matter, scattered over the outside of the spor-
angial wall.

On the bark of the log at Jericho, Long Island, previously men-
tioned, the two forms were found about equally divided in num-
bers, in fair abundance, and associated with *P. chrysosperma*, *P.
corticalis*, and other forms of the genus *Perichaena*. The spor-
angia are scattered, sessile, globose to subglobose, 0.2 to 0.5 mm.
diam. Stalked forms were not observed, nor plasmodiocarps.
The color of the typical form is dull yellow, and some of the
sporangia have one or a few warts like in var. *pardina*. The
variety has many of the characteristic warts, and between them
the color is dull yellow or brownish when some of the refuse matter
is present between. The sporangial wall is membranous, trans-
lucent, with stippling or papillae like in *P. chrysosperma*. The
characters of the spores are of little significance as they are similar
to the spores of all the associated forms of *Perichaena*, pale yellow,
faintly marked, about 11 μ diam. The netted, yellow capillitium
has threads 2.5–3.5 μ thick, irregularly constricted with many
large, bulbous expansions, and large swollen free ends. The
capillitium varies slightly in different sporangia.

When the capillitium is observed with an objective of inferior numerical aperture, faint groups of narrow, diagonal lines are seen on the threads here and there, not continuous, and often absent. Their direction is sometimes dextral and other times sinistral, and they do not seem to wind around the threads as they are not seen on the edges. They are not like the thickenings in the form of distinct windings found in the genera *Trichia* and *Hemitrichia*. When the same thread is observed with an apochromatic objective of N. A. 1.40, no lines or spiral windings are seen. The edge of the thread is studded with many close-set, minute, spines, less than 0.5 μ long. On the surface are numerous minute puncta, close together, which are the spines. Sometimes they are arranged in quincunx, like the puncta on the valves of many species of the Diatomaceae. At other times certain groups stand out more distinctly. All this tends to form diffraction illusions when an objective is used that will not resolve the lines into their component structure. The forms belong in the genus *Perichaena*, and not in *Hemitrichia*, in which latter genus there are true bands that wind around the threads.

The species has been reported heretofore naturally only from Japan and England, although Gilbert and Martin obtained it in moist chamber developments on material from Iowa and Ontario (Ia. Stud. Nat. Hist. **15** (3). 8. 1933). Miss Lister (Mon. ed. 3. 244. 1925) notes its association with *P. chrysosperma* in a collection from Japan. The capillitium resembles that of *P. vermicularis* (Schw.) Rost., but the latter was not associated in the Long Island gathering. The sporangia resemble the globose ones of *P. chrysosperma*, particularly the few that have similar dark warts like those on var. *pardina*. The typical form and var. *pardina* may be connecting forms, but have now been found in widely separated parts of the world, usually together, and seem to be good centers. The variety is far more distinctive than the typical form. More collections are required for the study of these interesting forms. N. Y. B. G. Nos. *2182, 2183, 2185.*

PHYSARUM ALPINUM G. Lister. The species is based primarily on a collection made by Harkness in the Blue Canon, California, and named in Phillips' herbarium *Badhamia inaurata*, which name was not published. No other collections like the California one

are known, except that Macbride (N. A. Slime-Moulds ed. 2. 55. 1922) mentions specimens from Washington believed to be the same, and indicates a relationship with *Physarum contextum* Pers. The California specimen is so strikingly different from *P. contextum*, that this record must be considered as somewhat doubtful.

The Harkness specimen was referred to by Lister (Mycetozoa 61. 1894), and then placed doubtfully with *Physarum rubiginosum* Fries. Later, A. & G. Lister (Jour. Bot. **46**: 216. 1908) proposed the form as var. *alpinum* of *Physarum virescens* Ditmar, including therewith certain forms from Switzerland. Neither the American nor the Swiss form has any resemblance to *P. virescens*. With additional material from Switzerland, Miss Lister (Jour. Bot. **48**: 73. 1910) proposed both forms jointly as *P. alpinum*. A portion of the Harkness collection, finely matured, is in the Herbarium of the New York Botanical Garden, and the Swiss forms are represented by five specimens received from M. Ch. Meylan.

The fructification of the California gathering is sporangiate, the large, sessile, subglobose, scattered or loosely clustered sporangia ranging from 1 to 1.4 mm. diam., and seated on a membranous hypothallus. The sporangial wall is double, the outer a dense crust of yellow lime, lightly affixed, and separating in flakes from the white, membranous, inner layer. The capillitium is a network of hyaline threads, with numerous large, angular and branching, yellow or yellowish lime-knots. The spores are purplish brown, faintly warted, 11–12 μ diam. The Swiss forms are in plasmodiocarps, some of them more than 25 mm. in length. The walls of the plasmodiocarps are firm, with massive, very pale yellow lime. Some of the few smaller plasmodiocarps, which may be considered as sporangia, have conical masses of lime arising from the bases, like columellae, and in some of the larger ones these are extended as low ridges. The lime-knots are small, angular and pale yellow. The spores are similar to those of the American form. The Swiss forms bear a close resemblance to *Physarum vernum* Somm., with which Miss Lister says they are associated, and may possibly represent a pale yellow phase of that species. They are surely not like the Harkness specimen, which,

if further similar gatherings are found constant, should be re-garded as typical of the species, and the Swiss forms separated.

PHYSARUM AURISCALPIUM Cooke.   In an earlier Note (Myco-logia **29**: 402.   1937) I discussed the relations of this species to *Physarum oblatum* Macbr. and to *Physarum Maydis* (Morg.) Torr. Since then much additional material has been acquired, so that now there are more than 175 specimens of the three forms in the Herbarium of the New York Botanical Garden.   A careful study of these specimens leads to the conclusion that *P. auriscalpium* and *P. oblatum* are distinct species, and that *P. Maydis* is a small phase of *P. oblatum*.

There are 30 specimens here of the form regarded as the true *P. auriscalpium* of Cooke.   I know of no type material of *P. auriscalpium* existent in this country, although portions of the type specimen were in the British Museum and the Kew Herba-rium at the time Lister examined them and published his descrip-tion (Mycetozoa 61.   1894), and which he placed then provision-ally with *Physarum rubiginosum* Fries, a sessile form.   My opinion is therefore based on that description, the figures through the various editions of the Lister Monograph, and the original de-scription of Cooke (Ann. Lyc. Nat. Hist. N. Y. **11**: 384.   1877). Both descriptions mention an almost obsolete stalk.

A description based on the 30 specimens follows: ·

Sporangia gregaricus or clustered and angled by mutual pres-sure, sessile, circular to irregular shapes, pulvinate or depressed, 0.5 to 1.2 mm. diam., or forming short, curved or straight plasmo-diocarps, mottled with brown, red, yellow, or white, with a dark red or brown inner base; sporangial wall membranous, firmer and persistent below, yellow, speckled on the outside with large, sepa-rated, clusters of reddish, yellowish, or white lime-granules; capil-litium consisting of many large, angular, branched, or netted lime-knots, yellow, pale yellow, or nearly white, rarely tinged with red, connected by long or short hyaline threads; spores violet-brown, spinulose, 9–12 μ diam.

These forms differ from *P. oblatum* by the size and shape of the sporangia; the absence of distinct stalks; and the speckled ap-pearance due to the vari-colored lime-granules on the outside of the sporangial wall, which distinguishes them also from every

related species of *Physarum* except *P. Braunianum.* There may
be traces of stalks at times, but I doubt it, and more likely, they
are cases where a sporangium is perched by the center of the base
upon a slight elevation of the habitat.   *P. oblatum* is never sessile,
except in imperfectly developed parts of an otherwise stalked
colony, and the stalks are always long enough to indicate their
character.   A description of *P. oblatum* will be found in the
present series of notes.

The capillitium of *P. auriscalpium* may be *Badhamia*-like occa-
sionally, and may be mistaken then for *Badhamia decipiens*
(Curt.) Berk., but the latter species is always yellow, does not
have the speckled appearance of *P. auriscalpium*, and resembles
more the imperfectly developed, sessile phases of *P. oblatum*,
which however are rare.

There remains the question that Cooke's specimen from South
Carolina may be an imperfectly developed, sessile form of *P.
oblatum.*   In that case a name must be given to the present form
which is not *P. oblatum* nor *B. decipiens.*

PHYSARUM BRAUNIANUM de Bary; Rost. Mon. 105.   1875.

Sporangia sessile, subglobose, 0.3 to 0.5 mm. diam., scattered or
clustered but not heaped, not rugose, brown or reddish brown,
speckled with many pale spots, sometimes without lime and then
uniformly purplish brown; sporangial wall membranous, yellow,
with separated included clusters of white or pale yellow lime-
granules, often streaked with red; capillitium a network of hyaline
threads with numerous small, angular or branching, white, yel-
lowish, or brownish lime-knots; spores violet-brown, spinulose,
8–10 μ diam.

The form is mentioned in the first edition of the Lister Mono-
graph on page 63 with a description in English.   In the second
and third editions it is regarded as synonymous with *Physarum
lateritium* (Berk. & Rav.) Morg., and figured in both on plate 61,
fig. d.   A comparison of the figure with that of *P. lateritium* on
plate 60 is almost sufficient to show they are different species.
P. Braunianum differs from *P. lateritium* in the much smaller
sporangia and absence of plasmodiocarps; the angular lime-knots
without red centers; and the sporangial wall, which in *P. lateritium*
has an outer crust of scarlet or yellow lime-granules, lightly

affixed, and breaking away in fragments from the inner, membranous wall.

There are sixteen collections of *P. Braunianum* in the Herbarium of the New York Botanical Garden personally made in the States of New Hampshire, New York, and Pennsylvania, and six more by other students in Massachusetts, Florida, and Pennsylvania. All are constant and uniform in the characters given. The differences between them and the type material of *P. lateritium* collected by Ravenel in South Carolina (N. Y. B. G. No. *11566*) are so pronounced, that it is strange the two forms were ever united. The true *P. lateritium*, common in eastern North America, is probably rare in Europe, or not well understood, and it seems to have been the practice to regard specimens of *P. Braunianum* as representing the species. Two specimens here, found by Mr. H. J. Howard in Norfolk, England, and perhaps from the same collections mentioned by Lister (Mycetozoa ed. 3. 64. 1925) are *P. Braunianum*. No specimens of the true *P. lateritium* are here from any European correspondents.

PHYSARUM GILKEYANUM Gilbert, Am. Jour. Bot. **19**: 133. 1932.

No specimen has been seen. The species is based on a single colony of about 75 sporangia found in Oregon in March. The description and figures, with the sporangial shape, the wall with ridges, the persistent capillitium, the more abundant lime in the lower part of the capillitium, the spores, and the habitat, all in combination are strongly suggestive of a slightly abberant, but representative phase of *Physarum mutabile* (Rost.) Lister. The latter species is extremely variable, particularly in form and lime, but the persistent capillitium seems to be present in every collection.

PHYSARUM LEPIDOIDEUM Gilbert, Am. Jour. Bot. **19**: 133. 1932.

A specimen has not been seen. The species is based on a single collection made in Oregon in January, and upon the rounded scales of lime in the peridium, similar to those in the genus

Lepidoderma. Specimens with such scales are frequently found in several species of the calcareous genera other than *Lepidoderma*, and are due to wet or cold weather at the time of fruiting. They are rather common in the forms grouped around *Physarum notabile* Macbr., which includes *Physarum compressum* Alb. & Schw.   *P. lepidoideum* is probably a sessile phase of *P. compressum* in which the lime has been altered by moisture.   The effect may be produced experimentally by re-wetting some sporangia of *P. compressum* or *Diderma effusum* so that the lime is dissolved, and on again drying, the lime will often form in vitreous plates.   The lime in the expansions of the capillitium of sessile phases of *P. compressum* is also occasionally vitreous and transparent.

PHYSARUM NEWTONI Macbr. Bull. Nat. Hist. S. U. Iowa 2: 390. 1893.   The original description by Macbride is as follows:

Sporangia simple, gregarious, short stipitate or sessile, globose or flattened, when not globose depressed and deeply umbilicate above, purple, smooth, thin-walled, stipe when present very short and concolorous; columella none; hypothallus none; capillitium abundant, delicate, with more or less developed nodules, which are also concolorous; spores by transmitted light, dark brown, thick-walled, rough, nucleated, about 10 μ.

The description is based on the type collection from Colorado which I have not seen.   Two specimens from Japan, determined as the species by Prof. Emoto, differ materially from the description of the Colorado collection.   The sporangia are purple, globose, 0.6 mm. diam., on stalks 0.6 to 0.8 mm. high, arising from a circular hypothallus.   The sporangial wall is rough with many large clusters of purple lime-granules and refuse matter, thicker near the base, and persisting for nearly half the height of the sporangium.   There is no columella.   The capillitium has delicate branched, pale violet threads, attached to the sporangial wall and converging inward, with many irregular, purple lime-knots. The spores are purplish red, irregularly spinulose, 8–10 μ diam.

It is possible the Japanese forms may represent a different species, or the description of Macbride may be deficient, based as it is on a single collection.   N. Y. B. G. Nos. *7381, 8809.*

PHYSARUM OBLATUM Macbr.

Sporangia stalked, globose or subglobose, 0.4 to 0.6 mm. diam., yellow or pale yellow, roughened; sporangial wall membranous, yellow, with innate, closely set clusters of yellow or pale yellow lime-granules; stalk erect, slender, furrowed, 0.3 to 0.8 mm. high, reddish brown, translucent; capillitium of many angular and branching yellow or pale yellow lime-knots connected by fairly long threads, sometimes a *Badhamia*-like network; spores violet-brown, spinulose, 9–12 μ diam.

Physarum ornatum Peck (Rept. N. Y. State Mus. **31**:40. 1879) is probably the same form. I have examined the type specimen in the New York State Museum, and while only stalks remain, they appear to be the same as those of *P. oblatum*, and the description of Peck, together with the fact that *P. oblatum* is common in New York, leads me to this belief. In view of the uncertainty, however, it is better to retain the later name of Macbride until a perfect and authentic specimen of Peck is uncovered.

P. oblatum is common on cottonwood poplar forming small colonies. *Physarum Maydis* (Morg.) Torr. is no more than a small phase found on other habitats, such as piles of decaying vegetable matter, twigs, and manure. There is nothing but size to differentiate it from *P. oblatum*. Many species, normally stalked, occasionally produce sessile sporangia. This happens rarely in *P. oblatum*, as the form seems to reach perfect maturity under nearly all conditions. Occasionally a few sessile sporangia, poorly developed, may be found associated with stalked ones. These sessile forms, when the capillitium is more *Badhamia*-like, will resemble sporangia of *Badhamia decipiens* (Curt.) Berk., but in the latter species, which is rare, plasmodiocarps predominate.

PHYSARUM PERFECTUM M. Peck, Am. Jour. Bot. **19**:134. 1932. No specimen has been seen. The author says various features suggest *Physarum melleum* (Berk. & Br.) Mass., but the color and greater size distinguish it. It is probably no more than a pale, robust form of that species. Similar forms are found in any large series of specimens of the latter form from different localities, as we have here.

PHYSARUM PEZIZOIDEUM (Jungh.) Pav. & Lag. Bull. Soc. Myc. Fr. **19**: 87. 1903. (N. Y. B. G. No. *11236*, authentic material.)

There seem to me no reasons whatever for keeping this species in a distinct genus, *Trichamphora*, as Junghuhn (Fl. Crypt. Jav. 12. 1838) proposed.   It is not only closely related to *Physarum javanicum* Racib., but in some instances the two forms are almost identical except for the stalks, and surely these are not of generic importance.   There is not a single, worthy character to distinguish *Trichamphora* from *Physarum*, and both species belong in the latter genus.

PHYSARUM SIMPLEX M. Peck, Am. Jour. Bot. **19**: 136.   1932. No specimen has been seen.   The author says it is related to *Physarum flavicomum* Berk.   The description and figure indicate it is a phase of that species or *Physarum tenerum* Rex, with the slight variations often present in either species.

PHYSARUM SUPERBUM Hagelstein.   A large, finely matured collection of this handsome species was made by young Robert H. Rispaud at Mineola, Long Island, in August.   The development appeared on a pile of dead leaves in the back yard of a house close to the home of Mr. Rispaud Sr. N. Y. B. G. No. *2155*.

STEMONITIS CONFLUENS Cooke & Ellis.   Collections of this species were made at Mitchell Field, Long Island, New York, in September and October.   It was again on oak bark, although now on the outside.   N. Y. B. G. Nos. *2158, 2227*.

TRICHIA LUTESCENS Lister.   In late August, there appeared on the bark of one of the logs at Mitchell Field, Long Island, the wood of which could not be determined, numerous solitary sporangia of this species, widely separated, and generally an inch or more apart.   A few were in small groups of from two to five. The sporangia are sessile, globose or bolster-shaped, pale olivaceous brown, showing the impressions of the inner spores, sometimes slightly iridescent, 0.2 to 0.5 mm. diam.   The sporangial wall is thin, membranous, yellow, translucent, almost free from granular matter.   The capillitium consists of long, simple elaters with little branching, and terminating in short, pointed tips, blunt or bulbous ends.   The spirals are distinct and in addition there are short, broad, blunt spine-like processes scattered along the elaters.   There is considerable variation, however, in different sporangia.   The spores are olivaceous in mass, pale yellow by transmitted light, and measure about 10 μ.

The species has been rarely reported from North America, probably because of the scattered habit, which makes it impossible to recognize in the field.   The olivaceous color of the spores in mass may be a means of separating it from phases of *Trichia contorta* (Ditm.) Rost., if other differences are obscure.   This may not be a constant feature.   N. Y. B. G. No. *2190*.

THE NEW YORK BOTANICAL GARDEN

NOTES AND BRIEF ARTICLES

THE POLYPORACEAE OF NEW YORK STATE (EXCEPT PORIA)

This paper, issued in 1942 as Technical Bulletin no. 60 of the New York State College of Forestry, Syracuse, New York, is a revision of bulletin 41 (1934) with a somewhat similar title. The bulletin consists of 128 pages and includes illustrations, keys to and descriptions of 8 genera and 141 species, a glossary, citation of literature, and an index. Under each species a relatively complete listing of synonyms, illustrations, and pathological literature are given. The pathological literature in foreign languages has been covered as completely as possible. Although the descriptive matter is complete, the keys and descriptions were made as simple as possible, to meet the needs of beginning and occasional students of the group. The bulletin is available from the Extension Department of the New York State College of Forestry at the actual cost of printing, 45 cents per copy—JOSIAH L. LOWE, author.

A NEW MUSHROOM BOOK

"Common Edible Mushrooms" by Clyde M. Christensen of the University of Minnesota, is the latest contribution in this fascinating field. With many of the older works out of print this one will be welcome.

This work is designed for beginners, and after a general discussion of mushrooms the author discusses what he calls "The Foolproof Four": the morels; the puffballs; the sulphur polypores; and the shaggymanes. These anyone can recognize and eat with impunity. Then some of the more difficult forms are treated, the reader being constantly warned that only those should be eaten, the identity of which is certain.

The neatly bound volume consists of 124 pages including bibliography of other works on mushrooms and index. There are 62 figures and 4 colored plates. It will be found exceedingly useful. —F. J. SEAVER.

United States. Dr. Kelly also obtained valuable old letters and manuscripts. The most noteworthy of those pertaining to botany were some of the letters of M. J. Berkley, Lewis D. de Schweinitz, and Charles H. Peck. He also acquired large numbers of illustrations of fungi and the library was replete with volumes of icones of fungi. Mr. Krieger made more than 300 exceedingly fine water color paintings of fungi for Dr. Kelly.

In 1928 Dr. Kelly presented his library, paintings and other gifts to the Herbarium of the University of Michigan. This has been designated, The L. C. C. Krieger Mycological Library and Collections. Included in the gift were collections of fungi made by Kelly, Krieger, Beardslee, Burlingham and others. In addition he gave a library of 400 items on the subject of Lichens which included important purchases from the library of Moritz Fünfstuck. Besides these there were exsiccati of lichens and fungi and a set of wax models of fungi.

Dr. Kelly was also actively interested in the field of zoölogy and was Honorary Curator of Reptiles and Amphibians in the Museum of Zoölogy of the University of Michigan.

Seldom does one find as gifted an individual as was Dr. Kelly. The results of his own research are immeasurable. However, his sympathetic appreciation of the needs of others working in scientific fields reflects no small part of his greatness. In his death not only the medical profession but his scientific colleagues throughout the world have lost a valued friend.

University of Michigan

SCLEROTINIA CARICIS–AMPULLACEAE, A REMARKABLE SUB–ARCTIC SPECIES

H. H. Whetzel and W. G. Solheim [1]

(WITH 6 FIGURES)

Most species of *Sclerotinia* on members of the Cyperaceae and Juncaceae appear to be restricted to the cooler areas of the north temperate zone. Very few have been described from the arctic and sub-arctic regions. One would expect them to be the most common pathogenic discomycetes in these cold areas, especially in sedges and rushes. Probably a goodly number of undescribed species on these suscepts in arctic and sub-arctic regions await the searchings of future hardy mycological explorers. It is, therefore, an especial pleasure to report a practically unknown species of this genus on *Carex*, discovered in and first described from Finland, and recently found to occur in a high mountain swamp in Wyoming.

In a letter of February 25, 1933, about three years after a collecting trip with him in Sweden, Dr. John A. Nannfeldt, of the Botanical Institute of Uppsala, wrote the senior author that he was sending "part of a collection (FIG. 6) of a *Sclerotinia* on *Carex aquatilis*," inquiring, "Is it *Sclerotinia longisclerotialis?*" The specimen, preserved in alcohol, arrived shortly. It had been collected June 25, 1932, near Lake Gärdsjön, Sweden by T. Lohammar. An examination soon disclosed that is was not *S. longisclerotialis*, but was, indeed, a splendid species, apparently undescribed. In replying to Dr. Nannfeldt it was proposed to describe it and name it in his honor.

A year later, a letter was received from Dr. Nannfeldt, saying "Yesterday I received a large lot of discomycetes from Finland, collected by an evidently very clever amateur Mycologist, Mr. Wolmar Nyberg, bank director in Borgå.   Among the fungi was rather abundant material of a species of *Sclerotinia* growing on *Carex ampullacea* Good (= *rostrata* Stokes = *inflata* Huds.).   He added a very long and full description of it with the *ad interim* name, *Scl. Caricis-ampullaceae*.   The finding place is a sphagnum bog on his own villa-ground, where it occurs every year."

Noting its similarity to the specimen he had sent the previous February, Nannfeldt said he was sending a part of the collection (FIG. 4) and a translation of Nyberg's description.   These were presently received.   He suggested that since the "finding-place" was so fortunately situated, fresh material could doubtless be obtained by writing Mr. Nyberg.

An examination of Nyberg's collection and a comparison of his preliminary description with the specimen Nannfeldt had first sent, left no doubt that the two were co-specific.

A letter to Nyberg on April 14, 1934, brought a prompt reply saying he would send fresh specimens as soon as they appeared. With a second letter, June 20, 1934, he sent cultures of ascospore shootings but they proved to be too badly contaminated to be of use.   Due to the few apothecia appearing that season, no additional specimens were received from Nyberg, nor were further letters or specimens received from him in the years following. Thus the only material of the species from Finland which we have is that part of Nyberg's type collection (June, 1931) sent by Nannfeldt.

Enclosed in Nyberg's letter of June 20 was a reprint of a short paper in Swedish (**1934**) in which he had already, early in the year, described the species and given it the name *Sclerotinia Caricis-ampullaceae*.

A translation of Nyberg's published description follows:

"A species of *Sclerotinia* on *Carix ampullacea,* which I have not found described in the literature to which I have access, and which I have called *Sclerotinia Caricis-ampullaceae* n. sp.

"Found by me in Borgå parish, in a bog in the vicinity of my summer home.   It grow from sclerotia formed in the crotch between leaf blade and culm of a dead *Carex* stand from the

FIG. 1. Apothecia in a mossy setting in the swamp in Medicine Bow Mts. June 1940. The apothecia are more usually found emerging from water. Approximately ½ natural size. Phot'd by Dr. C. L. Porter. The outside of the cups is powdered with tiny masses of pine pollen from nearby trees.

previous year, at 5–10 cm. depth under the surface of the sur-
rounding white moss. Collected the first time in the early part
of June, 1930, and every year since then at the same time. Older
fruit bodies were found a few times in July.

"The *sclerotia* which lay loosely, or had fallen from the blade
crotch are white inside, externally black, longitudinally sulcate,
often coarsely granulate; at first firm, later soft and easily crum-
bling, straight; bowed or S-shaped, fusiform, with the basal end
usually rounded, above gradually tapering and often drawn out
to a thread-like apex; varying greatly in form; the length varying
from 1–3 cm. to more than 10 cm.; in thickness from 1 mm. to
more than 1 cm. There is much shrinkage on drying, hence these
dimensions do not hold for dry specimens. On vigorous sclerotia
there grow as many as 20 fruiting bodies, on weaker ones often
but a single apothecium. Indeed the fewer the fruiting bodies,
the larger they generally are if the sclerotium is of normal size.

"The *apothecia* are often funnelform at first, later cup-shaped,
finally they are likely to be fairly flat, the surface being wrinkled
and tuberculate, often with the funnel-shaped umbilicus, so char-
acteristic of young fruiting bodies, still evident. They are gen-
erally about 2 cm. in diameter although the larger specimens may
attain a diameter of more than 4 cm. The height of the cup itself
is about that of its diameter when young, thickness about 1 mm.
The outer surface of the cup is very finely tomentose. The color
of the outer surface as well as the hymenium is of varying shades
of brown, occasionally approaching a golden red. The consistency
of the cup is thready, tough, sometimes fleshy. The cups are borne
on cylindrical stipes 5–10 cm. long, 1–2 mm. thick, thicker above
where they pass over into the cups, thickened at the base, darker
than the cups, nearly black and coarsely tomentose. The upper
half only, of the stipes, protrudes above the moss.

"The *asci* are cylindrical, obtuse and rounded at the apex, which
is usually thickened, opening by a terminal pore which gives a
weak blue iodine reaction at the very tip; dimensions 200–230
× 11 μ.

"The *paraphyses* are threadlike, scarcely enlarged at the tips,
branching below, septate, of the same length as the asci, colorless,
1–2 μ in diameter.

"The *spores* are oval, 11–15 × 6.5–9 μ, hyaline, smooth, without
oil drops, uniseriate in the upper part of the ascus.

"Without any distinguishing taste or odor."

DISCOVERY OF THE SPECIES IN THIS COUNTRY

During the winter of 1937–38, the junior author spent sabbatical
leave as visiting professor in the Department of Plant Pathology

at Cornell University.   During conversation one day, he described an unusually large and striking species of *Sclerotinia* on a species of *Carex*, which had been discovered by his colleague, Dr. C. L. Porter, in a swamp high in the Medicine Bow Mountains, near the summer camp of the science departments of the University of Wyoming.   Sphagnum does not occur in this swamp but aquatic or semi-aquatic mosses grow in abundance among the *Carex* plants.

Early in January, 1939, the junior author sent to Ithaca, a part of the original collection (FIG. 5) made by Dr. Porter on June 18, 1937.   As the senior author was then about to depart on a collecting trip to Venezuela, the specimen was set aside for examination and study upon his return the following May.   Unfortunately a long siege in the hospital, after his return, delayed the anticipated study of the specimen.

Meanwhile the junior author made a second collection of the *Sclerotinia* in the same locality on June 26, 1939, and obtained ascospore cultures.   In a letter of December 22, 1939 he wrote that he was sending these cultures to be followed later by dried apothecia of the 1939 collection.

Having partially recovered from a summer in the hospital, the senior author was able to return to his laboratory early in January, 1940.   He immediately made a study of Porter's collection reporting in a letter of January 19 to the junior author, "Since writing you on January 9, I have found time to examine rather critically the specimen of that *Sclerotinia* of yours on *Carex* which you sent me preserved in liquid in January, 1939.   I intimated in my letter of January 9, 1940, that this might be identical with a species I had from Finland some years ago.   A preliminary comparison of your fungus with the Finland species seems to confirm my hunch."   Following a short discussion of the marked similarities of the Finnish and Wyoming specimens and their slight differences, he remarked, "For the present, therefore, I am referring your species to *Sclerotinia Caricis-ampullaceae* Nyberg."

Shortly thereafter specimens of the June 26, 1939, collection together with a long letter (January 27) containing much pertinent information was received from the junior author.   He reported that the *Carex* is *"C. aquatilis,"* remarking "This is rather interesting since it is one of the species * * * that the fungus

occurs on in Sweden." He pointed out that this second collection he was sending confirmed the senior author's assumption that the larger end of the sclerotium fits into the crown of the diseased *Carex*, that it arises within the culm, breaking out below as it grows and matures, the long slender tip remaining embedded in the culm. Speaking of the place of collection he says, "The habitat is a typical swamp with an abundance of *Carex* and scattered willows. The *Carex* plants grow partially submerged in the water, and at the time of collection, the sclerotia were completely submerged. The apothecia emerge from the water at the time of discharge of spores." With the specimens and data now in hand there was no longer any doubt as to the specific identity of the Wyoming species with Nyberg's *S. Caricis-ampullaceae.*

However, there still remained many questions of special interest regarding the life history of this species and its possible occurrence on other species of *Carex* in this country. The senior author had planned to spend a month during June and July, 1940, at the University of Wyoming's summer camp in the hope that more complete data might be obtained on the infection of *Carex* by the *Sclerotinia* and on the spermatial stage and early developments of the sclerotia. Unhappily the trip had to be foregone. The junior author then wrote that he would undertake to make, during 1940, the collections and observations necessary to complete the picture of the seasonal developments of this *Sclerotinia*. The desire to obtain a likeness of the apothecia in their natural setting was gratified by the superb photograph taken by Dr. Porter (FIG. 1). New ascospore cultures were obtained. Visits to the locality were made by the junior author during June and July and again in early September and finally on October 14. From collections and observations which he made and sent the senior author, photographs of the spermodochidia [2] and of the mature sclerotia (FIGS. 2 and 3), as well as data on their development during the summer and autumn have been secured. No collections were made during 1941.

[2] For definition of this term and discussion of the spermatial fruit-body in species of *Sclerotinia* attacking members of the Cyperaceae and Juncaceae see Whetzel, Mycologia **35**: 335. 1943.

During June, 1942, the junior author again made abundant collections of the apothecial stage and obtained new cultures from the ascospores. He also again collected this species on *Carex inflata* Huds. (= *C. rostrata* Stokes). He had reported finding it (letter of Dec. 12, 1940) on what he took to be this species on October 14, 1939.

LIFE HISTORY OF S. CARICIS-AMPULLACEAE

The sequence of events in the seasonal development of this species parallels almost exactly that already described by Whetzel (1929: 26) for *S. longisclerotialis*. Apothecia do not appear and mature their ascospores for discharge until late June, but they have mostly disappeared by early July, their period of maximum spore discharge being correlated rather closely with maximum pollination activities of their *Carex* suscepts. Invasion is apparently *via* the male flowers as may be deduced from the fact that the male flower-spikes located above the female spikes are always the first to show the browning and dying which is finally evident in the culms in late July. The progress of the invading mycelium downward in the culms appears to be relatively slower than is that of *S. longisclerotialis*, due possibly to the lower seasonal temperatures of the sub-arctic environment. The spermodochidia (FIG. 2) do not mature and discharge their spermatia until late September or early October, whereas those of *S. longisclerotialis* are mature and functioning during late June and early July. Sclerotial development also is slow, the single large sclerotium formed in each infected culm (FIG. 3) being scarcely detectable before early October but maturing very rapidly thereafter. Mature sclerotia of *S. longisclerotialis* are frequently to be found in June in the swamps about Ithaca, N. Y. The sclerotia or *S. Caricis-ampullaceae* usually remain partially enclosed in the culm throughout the winter. The large rounded base is firmly bedded in the base of the diseased culm, being held in place by the stiff sheath of dead leaves. The long slender tip remains encased above, so that only the large lower half is exposed by the ruptured culm. It is from this exposed surface that the apothecia, usually several to many (FIGS. 4, 5, and 6), arise in fasciculate fashion. The lower part

of the diseased culms containing the sclerotia remain completely
submerged or frozen in the ice during the winter.

The groups of spermodochidia when fresh and moist appear as
black more or less tuberculate swellings along the upper half of
the killed culm.   When dry they are to be detected only as groups
of parallel dark lines up and down on two faces of the shrivelled
culms.   They are arranged at intervals along the culm (FIG. 2)
as in *S. longisclerotialis* and in *S. Duriaeana* though occasionally
less regularly disposed.   There can now be little or no question
that the spermatia of this as well as those of the other species of
Sclerotinia on *Carex* are functional, fertilizing in some way, as yet
unknown, the then forming sclerotia in the culm below.

TECHNICAL DESCRIPTION

Although Nyberg's description, the translation of which is pre-
sented above, is perhaps sufficient to identify the species, there are
several structures and features which he does not mention.   It
seems proper, therefore, to offer here a more complete diagnosis.

Spermatia, hyaline, globose or ovate, 2.5–3 μ in diameter; borne
in dark-colored spermodochidia grouped at rather regular intervals
on two faces of the culm just below the inflorescence; oozing forth
in mucilaginous drops through a longitudinal slit in the epidermis
over each spermodochidium; produced endogenously from ob-
clavate spermatiophores densely clustered at foci to form what are
in fact numerous naked spermodochia in the spermodochidial cavi-
ties in the culms.   The structure and development of these spermo-
dochia is essentially like that illustrated for *S. longisclerotialis*
(Whetzel **1929**: *fig. 23* [3]).

Sclerotia, cylindro-conical, ventricose below with rounded or
bluntly attenuated base, gradually elongated above into a slender
whiplike apex, variable in size, up to 20 cm. long by 1 cm. thick

[3] The legends for the plates in this article are incorrectly numbered.   There
is no text figure.

FIG. 2.   Culms of *Carex aquatilis* var. *altior,* showing spermodochidia in
fresh condition (October).   Note the tendency to equal spacing along the
culm and exposure of the spermatial masses by slits on two faces of the
culm.   Natural size.   FIG. 3.   A mature sclerotium (October) freed from
the surrounding culm tissues and leaf bases except at very base and at tip.
Normally at this time almost completely enclosed.   Natural size.   Many
sclerotia smaller and more slender than this one.

FIGS. 2–3.

near the base, developed within the slender 3 angled culm, the base firmly nestled in the very base of the culm and the enclosing bases of the leaves, the lower half breaking forth through one face of the culm, the slender pointed tip firmly enclosed above in the culm, black without, sulcate, granulate, firm and white or pale pink within, structurally, the medulla consisting of densely interwoven, large, thick-walled hyphae, enclosed in a rind composed of smaller, densely packed, short hyphal-cells, the outer walls of which are impregnated with a black material.

Apothecia usually several to many (up to 20), fasciculate, arising from one point on the exposed surface to the sclerotium, long stipitate; the *cup* shaped like a thistle-funnel, finally becoming more or less urceolate to flat expanded, umbilicate, vinaceous brown to reddish brown, relatively thin (1 mm.), 4–22 mm. in diameter by 7–16 mm. deep, underside finely tomentose; *stipe,* variable in length (1.6–7.5 cm. long by 1–3 mm. thick) depending upon depth to which the sclerotia are immersed in the water or buried in the mosses, the cup and upper part of the stipe protruding; slender, flexuous, attenuated toward the point of attachment, upper part concolorous with the cup, base nearly black, coarsely tomentose; *asci,* cylindrical, narrowed below, obtuse or rounded above and somewhat thickened at the apex, pore faintly J +, 200–230 × 11 μ,[4] 8-spored, uniseriate; *ascospores,* ellipsoid, hyaline, smooth, without oil drops, 11–15 × 6.5–9 μ,[4] on germination in water often forming spermatiophores with spermatia at one or both ends; *paraphyses,* filiform, hyaline, branched near the base, scarcely enlarged at the tips, not exceeding the asci, 1–2 μ in diameter.

In *culture on potato dextrose agar* this species forms dense, white, cottony mats of aerial mycelium, reminiscent of those pro-

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[4] These measurements are those given by Nyberg, presumably from living material. The following measurements by the junior author from his fresh material approximate those given by Nyberg: *asci* 192–213 × 11.8–13.5 μ; *ascospores* 13.5–16.9 × 8.5–10 μ. Measurements from dried specimens run appreciably smaller as might be expected.

Fig. 4. A part of the type specimen in *Carex inflata,* from Finland (dry). Sclerotium largely enclosed below. Collected June 19, 1931. (C.U. *28912*). Fig. 5. A fascicle of young apothecia attached to a sclerotium, the base of which is broken off. From the original collection by Dr. C. L. Porter in the Medicine Bow Mt. swamp (C.U. *28910*), June 18, 1937. Specimen received in liquid preservative. Washed out and floated in water for photographing. Fig. 6. Apothecia attached to sclerotium still partly enclosed in base of leaves of *Carex aquatilis.* Part of specimen collected near Lake Gärdsjön, Sweden, June 25, 1932, received in liquid preservative, washed out and floated in water for photographing (C.U. *21965*).

FIGS. 4–6.

duced by *S. sulcata* (Whetzel **1929**: *fig. 16*). No sclerotia are formed, however. In about 4 to 6 weeks black bodies of varying size appear in the hyphal mat. These consist of numerous closely packed spermodochia embedded in the mucilaginous mass of spermatia. The dark color of these spermodochia is due to a brown coloring matter in the spermatiophores, and in the spermatia, evident only in mass. These spermodochia produced in culture are in appearance and structure like those formed by *S. sulcata* and *S. longisclerotialis* on potato dextrose agar (Whetzel **1929**: *figs. 16 and 19*).

Habitat: [5] In culms of *Carex aquatilis* Wahl. (*typica*), *C. aquatilis Wahl.* var. *altior* (Rydb.) Fern. and *C. inflata* Huds. (= *C. rostrata* Stokes = *C. ampullacea* Good) in wet sphagnum bogs of sub-arctic regions and in high mountain swamps of the north temperate zone.

Distribution: In Europe, known only from the type locality in Finland, and from a collection made near Lake Gärdsjön in Sweden; in North America, from several collections from a swamp (alt. 9600 ft.) in the Medicine Bow Mountains in Wyoming.

Type Specimen: Collected by W. Nyberg on *Carex inflata* Huds. (= *C. ampullacea* Good) in a sphagnum bog near Vessö, Borgå parish, Finland, June 19, 1931. Duplicates from this collection deposited in the Botanical Institute, Uppsala, Sweden and in Cornell Univ. Pl. Path. Herb. No. *28912*.

Herbarium Material: In addition to the type material the following collections have been studied:

From *Sweden:* On *Carex aquatilis* Wahl. (*typica*), Selet near Lake Gärdsjön, prov. Västerbotton, parish Lövanger, June 25, 1932. Coll. G. Lohammar (apothecia). Duplicate in Bot. Inst., Uppsala, Sweden and in C. U. Pl. Path. Herb. No. *21965*.

From *Wyoming:* In the Medicine Bow Mts. in a swamp (alt. 9600 ft.), below Nash Fork bridge near the Science Camp of the University of Wyoming, in Albany Co. Duplicates of most of the following collections are deposited in the "Rocky Mountain Herbarium" (R.M.H.) of the University of Wyoming, Laramie; in

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[5] The names here used for the species of *Carex* have been determined by Dr. R. T. Clausen of Cornell, to be those now regarded as legitimate.

the private herbarium of W. G. Solheim (S) ; and in the herbarium of the department of Plant Pathology at Cornell University (C.U.) :

On *Carex aquatilis* Wahl. var. *altior* (Rydb.) Fern.

(1) Coll. C. L. Porter, June 18, 1937 (apothecia), R.M.H. *188343* = S. *7319* = C.U. *28910.*

(2) Coll. W. G. Solheim and C. L. Porter, June 26, 1939 (apothecia), R.M.H. *182767* = S. *4738* = C.U. *31535.*

(3) Coll. W. G. Solheim, June 22, 1940 (apothecia), R.M.H. *188344* = S. *6796* and *6797* = C.U. *31536A.*

(4) Coll. W. G. Solheim, July 29, 1940 (early stages of infection), R.M.H. *188345* = S. *6807* = C.U. *31536B.*

(5) Coll. W. G. Solheim, Sept. 6, 1940 (young sclerotia), R.M.H. *188346* = S. *6757* = C.U. *31536C.*

(6) Coll. W. G. Solheim, Oct. 14, 1940 (spermodochidia and mature sclerotia), R.M.H. *188347* = S. *6806* = C.U. *29268.*

(7) Coll. W. G. and R. Solheim, June 27, 1942 (apothecia), R.M.H. *188342* = S. *7318* = C.U. *31537.*

On *Carex inflata* Huds. (= *C. ampullacea* Good).

(8) Coll. W. G. Solheim, Oct. 14, 1940 (sclerotia), S. *6808* = C.U. *31608.*

(9) Coll. W. G. and R. Solheim, June 27, 1942 (apothecia), C.U. *31539.*

Specimens of the June 26, 1939, collection have been distributed by Solheim under No. *204* in Mycoflora Saximontanensis Exsiccata. Duplicate specimens from certain of these Wyoming collections have been distributed to the following herbaria: Farlow Herb., Harvard Univ.; N. Y. Bot. Gard.; Mycol. and Pl. Dis. Survey, Bu. Pl. Ind., Washington, D. C.; Univ. Toronto, Canada; Univ. Museum, Ann Arbor, Mich.; Missouri Bot. Gard., St. Louis, Mo.; British Museum, London; and Royal Herb., Kew, England.

TAXONOMIC RELATIONSHIPS

That *S. Caricis-ampullaceae* is closely related to *S. longisclerotialis* as Nannfeldt's original query suggested is not to be denied.

The long, slender sclerotia remaining more or less anchored in the diseased culm, the spermodochidia grouped at intervals in the culm, and the peculiar thistle-funnel form of the apothecia all point unmistakably to this relationship.   The similarity of the habitats and habits of the two is also significant in this connection.   The apothecia of both arise from sclerotia typically submerged in water from which they must emerge to expand and expose the hymenium to the air for effective discharge and dissemination of their ascospores.   The extraordinary size of the apothecia of *S. Caricis-ampullaceae,* and the peculiar cylindro-conical shape of its sclerotium are, however, alone sufficient to set it apart as distinct from its close relative, which moreover is not known to affect any of the species of *Carex* on which *S. Caricis-ampullaceae* occurs.

The only other species of *Sclerotinia* known to the writer which might be confused with *S. Caricis-ampullaceae,* is *Sclerotinia Vahliana* Rostrup, originally described from collections made in Greenland, but known to occur in several localities in Scandinavia and in Iceland.   The apothecia of the two species are not strikingly different in appearance or structure, but the sclerotia of *S. Vahliana* are quite different in shape and size from those of *S. Caricis-ampullaceae.*   They are compressed, curved, often approaching the form of a hollow sphere open at the ends and along one side.   The two species occur on members of different genera, *S. Vahliana* being known only on species of *Eriophorum.*

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LITERATURE CITED

Nyberg, Wolmar.   Några i Borgå och dess omnejd funna, sällsyntare svamp-arter.   Memoranda Soc. pro Fauna et Flora Fennica.   **10:** 20–23.   Helsingforsiae.   1934.

Rostrup, E.   *Sclerotinia Vahliana* n. sp.   *In* Tillaeg til "Grönlands Svampe (1888)" Meddelelser om Grönland.   **3:** 607.   1889.   (Reprint dated 1891.)

Whetzel, H. H.   North American species of Sclerotinia II—Two species on *Carex, S. Duriaeana* (Tul.) Rehm, and *S. longisclerotialis* n. sp.   Mycologia 21: 5–32.   1929.

THE DEVELOPMENT AND STRUCTURE
OF LONGIA TEXENSIS

HORACE L. BARNETT

(WITH 3 FIGURES)

Until recently *Longia texensis* (Berk. & Curt.) Zeller, was included in the genus *Gyrophragmium*. Zeller [1] has discussed the nomenclature regarding this species and has described the new genus *Longia*.

The taxonomic position of the genus *Gyrophragmium* among the Gasteromycetes has been questioned by some mycologists. Fischer (6), while placing it in the Gasteromycetes, regards it as close to *Montagnites*, which he places in the Agaricaceae. Conard (5) states that *"Gyrophragmium* may prove to be near *Secotium,"* which he believes to be near *Agaricus*. Lloyd (7) says that *Gyrophragmium* "has no place in the Gasteromycetes. Its relations are more close to the Agarics. It is the connecting link between the two passing on one hand through *Montagnites* to *Coprinus* and on the other through *Secotium* to the true Gasteromycetes." Morse (8) believes that *Gyrophragmium* and *Endoptychum* form a transition between the Gasteromycetes and the Hymenomycetes.

Because of the uncertain taxonomic position of the genus and because of the local abundance of material the writer became interested in the present developmental study of *Longia texensis*. It was hoped that the study would throw some light on its true relationship to certain other genera, especially *Secotium, Endoptychum, Podaxis, Montagnites, Coprinus,* and *Agaricus*.

THE MATURE FRUIT BODY

An abundance of fruit bodies in all stages of development was found on or near the campus at State College, New Mexico. Considerable variation was found in the size of the plants and the scaliness of the peridium. These variations were thought to be

due primarily to the moisture conditions during growth. The fruit bodies were found only in sandy soil. Some appeared in bare soil devoid of any cover, while others grew in areas sparsely covered with grass. The color of the fresh specimens is pure white at first, usually turning pale tan at full maturity. Dried plants are light gray or tan, often with some yellow. Fresh plants may turn yellow where injured or bruised.

Considerable variation was also found in the method of dehiscence of the peridium. Most of the specimens remain closed until maturity (FIG. 1, *A*). Upon desiccation, or soon afterward, short longitudinal slits usually appear near the lower edge of the peridium where it joins the stipe. Sometimes the slits occur higher up and sometimes only irregular breaks occur in the fragile peridium. Less commonly the peridium splits open in a circular manner, leaving an annulus on the stipe (FIG. 1, *B*). Some variations in the mature plants are also shown by Lloyd's photographs in his Mycological Notes, plate 23. figs. 1, 2, and 3 (as *Gyrophragmium decipiens*), and plate 24, fig. 5 (as *G. texense*).

At maturity the gleba becomes desiccated and remains intact. Apparently no autodigestion occurs. The spores are abundant and sift out of the peridium at the slightest jar. At maturity the spores are almost black with a slight tinge of purple.

THE DEVELOPMENT OF THE FRUIT BODY

One small area which was under frequent irrigation and where fruit bodies had appeared the previous season was observed during 1941. The first fruit bodies appeared above ground in early May. During the next three months five successive crops of fruit bodies appeared. Each time they were removed before reaching maturity. After that time no accurate observations were made. However, another crop appeared in October.

The fruit bodies make their appearance above the surface of the ground 2 or 3 days after a rain or an irrigation. It requires about 5 to 8 days to reach maturity. The rhizomorphs are slender, white and very fragile. They grow in a horizontal position 1 or 2 inches below the surface of the soil. The fruit bodies arise as enlarged tips of the upright branches of the rhizomorphs (FIG. 3, *A*). Numerous small, almost-spherical fruit bodies can be found

just beneath the surface of the soil.   Apparently a few fruit bodies
develop at the expense of the others.   Not until the fruit bodies
reach a diameter of about 4 to 6 mm. do the stipe and peridium
regions become distinguishable.   The peridium region first appears

FIG. 1.   *A*, Dried mature fruit body showing the typical upward peeling
of the partial veil, × ⅗.   *B*, Fresh mature fruit body showing an annulus,
× ½.   *C*, Immature fruit body cut open to show the character of the gleba
and the partial veil.   Photograph made from a preserved specimen, × ⅗.
D, median longitudinal section of a young fruit body 4 mm. in diameter,
× 30.   *E*, Tangential section of a fruit body 6 mm. in diameter, × 40.
F, Median longitudinal section of a fruit body 6 mm. in diameter showing the
young tramal plates and the centrifugal extension of the palisade layer, × 40.
G, Median longitudinal section of a fruit body 11 mm. in diameter, × 40.
The columella is at the right.

as a small swelling at the apex of the much larger stipe region. The fruit bodies push through the soil when they are about 2 cm. tall. As growth progresses the stipe elongates and the peridium becomes more rounded and increases in size until maturity. At about the time the peridium reaches 1 cm. or slightly more in diameter the tissue at the base of the peridium (the partial veil) begins to pull away from the stipe. Scales begin to appear on the surface of the peridium of some specimens at about this time. The younger stages are illustrated in figure 3, *A*.

The material sectioned during the present study was fixed in formal-acetic-alcohol and stained in Heidenhain's iron-alum haematoxylin with orange G as a counter stain. A longitudinal section of a very young fruit body (3 mm. in height) before the glebal cavity is formed shows that the structure is entirely uniform throughout, except for being slightly more compact near the upper part, which later is to become the peridium. No universal veil is present.

The annular glebal cavity first appears when the fruit body is about 3 or 4 mm. in diameter. It is formed by the separation of the tissue in a small area near the columella region and develops centrifugally. It soon appears as a narrow ring elongated in a radial direction (FIG. 1, *D*). The palisade layer begins to form before the glebal cavity appears. In the youngest material showing a cavity the palisade is present as a distinct layer lining the upper surface (FIG. 1, *D*). The contents of the hyphae of this layer are more deeply stained than those of the surrounding tissue. The tramal plates appear first as irregular downward projections from the palisade (FIGS. 1, *E, F, G*). The formation of these plates begins at or near the columella and progresses outward. In a median longitudinal section the older plates can be seen near the stipe region and younger ones toward the periphery (FIG. 1, *F*). The plates then extend downward to the base of the glebal cavity (FIG. 1, *G*).

A cross section of a young fruit body (9 mm. in diameter) near the top of the glebal cavity shows that the tramal plates run generally in a radial direction (FIG. 2, *A*). Some of the plates extend completely across the cavity. There appears to be some anastomosing of the tramal plates in the earlier development but little or

none in later stages. Lower down in the glebal cavity (FIG. 2, *B*) the plates appear to be shorter and more irregular, due to the frequent branching and continued downward growth in local areas rather than throughout their entire length. Meanwhile new tramal plates are being formed near the edge of the glebal cavity (FIG. 2, *B*). The new palisade extends centrifugally into the sterile tissue at the edge (FIGS. 1, *F;* 2, *C*) and is followed by the splitting of this tissue. The columella elongates and the glebal cavity becomes
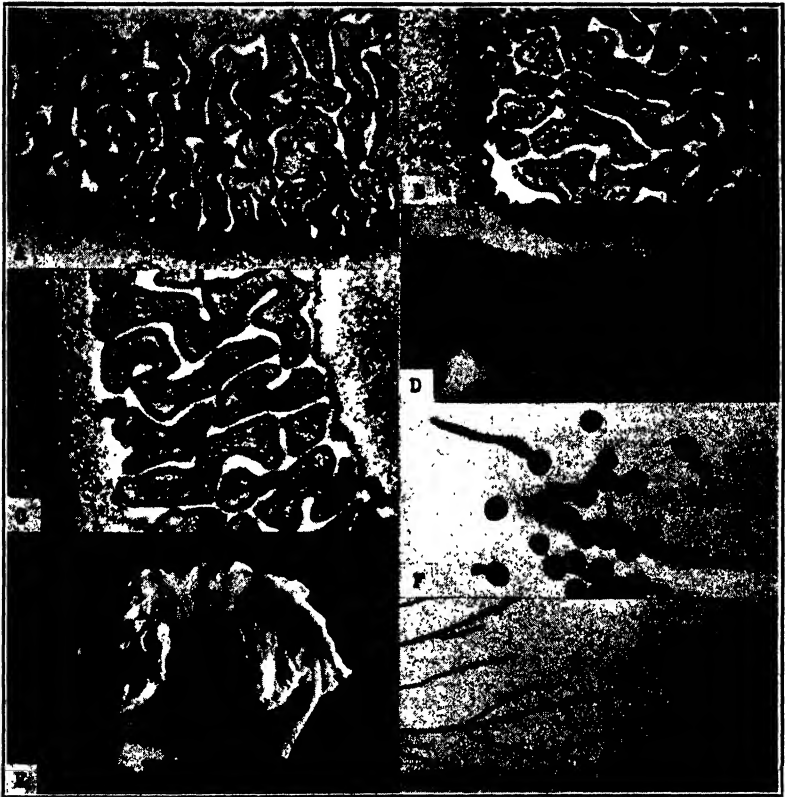
FIG. 2. *A*, Cross section of a fruit body 9 mm. in diameter near the top of the glebal cavity, × 40. *B*, Same as *A* lower down in the glebal cavity, × 40. *C*, Same as *A* near the base of the glebal cavity, × 40. *D*, Cross section through the gleba showing the structure of a tramal plate, × 250. *E*, Section through an immature fruit body showing the folded nature of the tramal plates, × 2. *F*, Spores germinating on a film of agar, × 750. *G*, Mycelium from a multisporous culture growing on agar, × 125.

more rounded and finally somewhat elongated in a longitudinal direction. Also during this time the tramal plates are growing downward, branching and folding in all directions, filling the entire cavity.

The tramal plates are entirely free from the columella, except at its very apex (FIG. 3, C). They are also free at the base of the cavity, being attached at the top and side of the peridium. The smooth hymenium extends downward on the curved surface of the peridium for some distance beyond the point where the last-formed plates are attached. Some tissue at the base of the peridium near the columella remains sterile.

In a median cross section of a half-mature fruit body (peridium 2 cm. in diameter) none of the plates were found to extend from one side of the glebal cavity to the other (FIG. 3, D). There appears to be two overlapping series of branched and folded plates. The one nearest the columella is thought to represent the first-formed plates, which extend outward and downward from the top of the cavity to or nearly to the base (FIGS. 2, E; 3, C). The plates of the second series are attached to the curving surface of the peridium and extend inward and downward. In thin sections the plates appear to form small cavities, particularly near the peridium wall (FIGS. 3, C, D). These appear to have been formed by the partial anastomosing of the tramal plates in the early stages of development, or represent sections through folds in the plates. There is no evidence that these small cavities are completely enclosed.

The dissection of an immature fruit body shows more clearly the way in which the tramal plates are folded and crowded into the glebal cavity (FIG. 2, E). The folding is more pronounced near the base. The gleba is at first white, then changes through gray and purple brown to almost black when the spores are mature.

The partial veil first becomes distinguishable when the fruit body is about 8 to 10 mm. in diameter. Only a faint line outlining the partial veil can be seen at this time in a microscopic view of a longitudinal section (FIG. 3, C). The structure of the partial veil seems to be very similar to that found in *Agaricus Rodmani* (1) and some varieties of *Agaricus campestris* (2). The lower limb of the double veil first becomes apparent in external view when it .

separates slightly from the stipe as the latter elongates. At this stage the veil is attached to the stipe by a rather broad band of tissue which is continuous above with the outer layer of the columella (FIGS. 1, *C;* 3, *C*). This latter feature is also shown to a certain extent in *Agaricus arvensis* and *A. comtulus* (**3**). Toward maturity the columella elongates rapidly, creating an upward tension on the tissue of the veil. In most specimens the attachment of the broad portion of the veil to the stipe is apparently weaker than is the veil tissue at the edge of the peridium. The tension, therefore, causes a separation of the veil from the stipe. The lower limb of the veil is then pulled outward and upward and the outer layer of columella tissue, being continuous with the veil, is in turn pulled upward (FIG. 1, *A*). This seems to be a more extreme case of the peeling which Atkinson (**2**) describes and illustrates for *Agaricus campestris* var. *columbia.* In *Longia texensis* the veil may be pulled entirely free from the stipe, leaving a circular opening around the stipe. The extremely dry atmosphere causes the fruit bodies to dry out immediately after maturity and the veil and peridium become very fragile.

Several specimens have been found which show a definite annulus on the stipe (FIG. 1, *B*). This annulus is very similar to that found on *Agaricus,* except that it is not so fleshy. It is thought that in those specimens which form an annulus the tissue connecting the partial veil to the stipe is much stronger than in those not forming an annulus. Thus, as the columella elongates, the tension tears the partial veil at the edge of the peridium, leaving most of it attached to the stipe as the annulus.

The hymenium is composed of densely packed basidia (FIG. 2, *D*) which arise as enlarged tips of the hyphal branches. No clamp connections were seen on any hyphae of the fruit body. No cystidia are present. Most of the basidia produce 4 spores, but some 2-spored basidia were seen (FIG. 3, *B*). The basidia elongate considerably just before the spores are mature. The nuclear behavior, as far as it could be traced, follows the usual pattern of the basidiomycetes. Four nuclei were seen in basidia producing 4 spores and likewise in those producing but 2 spores. The spores are borne on slender sterigmata and are not shot off from the basidia. All stages in the maturation of the spores can be seen

in a section of a half-mature fruit body. Most of the spores having clearly visible nuclei were uninucleate, but a few binucleate spores were seen. It is thought that only one nucleus enters each spore and may later divide before germination. Soon after the
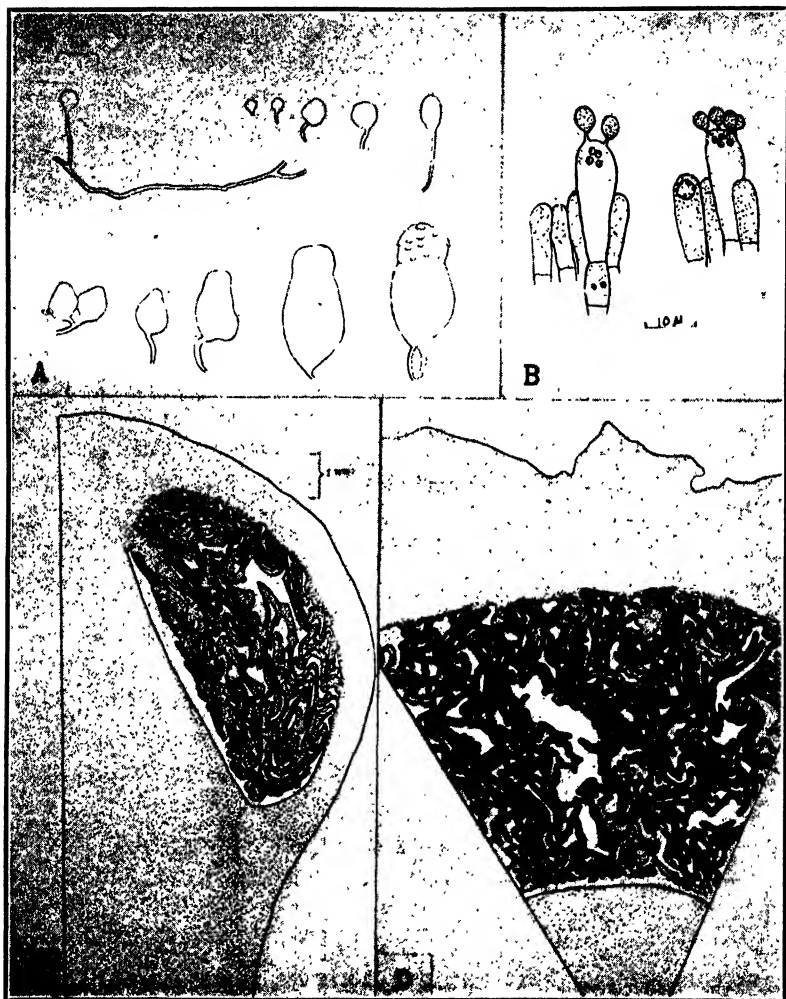
FIG. 3. *A*, Drawing of rhizomorph and very young fruit bodies. *B*, Basidia. *C*, Camera lucida drawing of a median longitudinal section showing the branched and folded nature of the tramal plates. *D*, Camera lucida drawing of a median cross section of an immature fruit body 2 cm. in diameter. Some of the plates are blackened so that they may be more easily traced.

spore reaches maturity the wall darkens and it is then impossible to see the nuclei. The spores are almost spherical and are 4.5–7 μ in diameter.

The spores germinate readily an agar (FIG. 2, F). Spores from fresh fruit bodies germinated only slightly better than those from dry fruit bodies several months old. It was estimated that only about 10 per cent germination was obtained. The mycelium resulting from the germination of many spores is pure white. Its growth is comparatively slow. Slender white rhizomorphic strands appear in older cultures.

Several single germinated spores were isolated and grown on agar. The mycelia which resulted from these were from all appearances like those developed from multispore cultures. Both types of mycelia were grown on agar slides and stained with Heidenhain's haemotoxylin. The multisporous mucelia showed from 2 to several nuclei per cell, the number usually being even. As many as 12 nuclei were seen in a few cells. No clamp connections were present. The cells of the monosporous mycelium contained from 1 to 8 nuclei each, the number being either odd or even. A rather unusual opposite type of branching (FIG. 2, G) was observed on the mycelia, one of the branches being formed before the other. Anastomoses of the hyphae were frequent.

CONCLUSIONS AND SUMMARY

1. The early development of the fruit body of *Longia*, especially of the annular glebal cavity and the palisade layer and the early formation of the tramal plates, agrees closely with that of some members of the Agaricaceae, particularly *Agaricus*. The additional fact that the partial veil of *Longia* is very similar in structure to that found in *Agaricus* tends to strengthen the belief that the two genera are closely related.

2. The older fruit bodies of *Longia* resemble more closely certain of the Gasteromycetes. The plants dry out and become fragile, and the peridium typically remains closed, or nearly so, for some time after the spores are mature. The spores are not shot off from the basidia but remain on the tramal plates and sift out after the peridium breaks open.

3. The presence of densely crowded, branched and folded trama plates which often anastomose and form partially enclosed cavities is similar to that found in *Endoptychum* (*Secotium*) *agaricoides* by Conard (**5**) and in *Podaxis pistillaris* by Brasfield (**4**).

4. *Longia* shows a closer relationship to the Agaricaceae than does *Secotium, Endoptychum* or *Podaxis*.

5. On the basis of the present study it seems that the genus *Longia* would logically fall in the Secotiaceae (if that family is recognized) of the Hymenogastrales.

6. The developmental studies of other genera, especially of *Montagnites,* may prove helpful in determining the true taxonomic position of the members of this group of fungi.

The author wishes to express his appreciation to Dr. S. M. Zeller for the loan of some reprints and for his helpful and stimulating letters.

LITERATURE CITED ·

1. **Atkinson, George F.** Morphology and development of *Agaricus Rodmani.* Proc. Am. Phil. Soc. **54**: 309–341. 1915.
2. ———. The development of *Agaricus campestris.* Bot. Gaz. **42**: 241–246. 1907.
3. ———. The development of *Agaricus arvensis* and *A.·comtulus.* Am. Jour. Bot. **1**: 3–22. 1914.
4. **Brasfield, Travis W.** The morphology of *Podaxis pistillaris.* Univ. Iowa Stud. Nat. Hist. **17**: 199–211. 1937.
5. **Conrad, H. S.** The structure and development of *Secotium agaricoides.* Mycologia **7**: 94–104. 1915.
6. **Fischer, Ed.** Hymenogastrineae in E. & P. Nat.-Pfl. I. **1**: 296–313. 1900.
7. **Lloyd, C. G.** Mycological Notes **1**: 195–197. 1904.
8. **Morse, E. E.** A study of the genus *Podaxis.* Mycologia **25**: 1–33. 1933.

NORTH AMERICAN SPECIES OF GALEROP-
SIS, GYROPHRAGMIUM, LONGIA,
AND MONTAGNEA [1]

S. M. Zeller

(with 1 figure)

The four genera, *Galeropsis, Gyrophragmium, Longia,* and *Montagnea,* along with *Secotium,* form a natural group in the Secotiaceae, which is one of the gasteromycetous families recognized as closely related to the Hymenomycetes.

The fructifications are stalked and more or less pileate, except in *Montagnea* where the pileous tissues are actually wanting. The gleba is mostly lamelloid but sometimes anastomosing until a more or less spongy, chambered condition results. In this group the gleba does not become a powdery spore mass at maturity, as in the Podaxaceae, nor does it rapidly decompose or deliquesce, as in certain closely related genera of the Agaricaceae. The stem is extended above as a percurrent columella. The spores are dark-colored in contrast to the echinulate or verrucose, hyaline or subhyaline ones in the *Elasmomyces-Macowanites* group.

The chief purpose of the present paper is to discuss these genera in relation to the species occurring in North America.

The writer acknowledges with appreciation the privilege of studying specimens made available by the herbaria of the University of California, Harvard University (Farlow), University of Michigan, and New York Botanical Garden, as well as the special aid rendered by Dr. W. H. Long and Dr. D. P. Rogers.

Galeropsis Velenovsky, Mykologia 7: 105. 1930.

Syn. *Psammomyces* Lebedeva. Trudy po Zaschtsch. Rastjenij.
V. 1932.

The following is an emended description.

Pileus cylindrical to conic, slender, acute above, dry, usually glabrous, drying tenacious, persisting, margin nude or with remains of cortina, stipe slender, tenacious, solid or hollow, mostly glabrous; gleba lamelloid, narrow, free, at first pale, then ochraceous; spores ovoid or ellipsoid, ochraceous, smooth, borne acrogenously.

This genus has affinities with the *Bolbitius-Galera* group of agaricaceous genera. Velenovsky considered it nearest to *Galera* through *G. hapala* Fries, while Singer [2] considers *Galeropsis* closely allied to his Bolbitioideae.

The type species is *G. desertorum* Velen. & Dvorak. (Mykologia 7 : 106. 1930) from Moravia. Other species previously assigned to the genus are *G. plantaginiformis* (Lebedeva) Singer (Syn. *Psammomyces plantaginiformis* Lebedeva), and *Galeropsis cucullata* (Shope & Seaver) Singer.[3]

There are two known species in North America as follows:

1. *Galeropsis cucullata* (Shope & Seaver) Singer.

   Syn. *Bolbitius cucullata* Shope and Seaver, Mycologia **27** : 649–650. *illus.* 1935.

   Secotium longipes Zeller, Mycologia **33** : 209–210. *illus.* 1941.

For a complete description of *G. cucullatus* reference may be made to either of the two citations above. Singer points out the similarity of this species with *G. plantiginiformis;* which has been reported from Turkestan and the Caucasian regions of Asia and Europe. This similarity is more apparent in the general stature and shape of the fructifications of the two species (See illustration of *G. cucullatus* in Mycologia **27** : 648. 1935) than in their microscopic characters. Young specimens of *G. cucullatus* have pileus with fibrils from the margin, and the basidia are gasteromycetous.

The other North American species is:

Galeropsis polytrichoides comb. nov.

   Syn. *Secotium polytrichoides* Zeller, Mycologia **33** : 211–212. *illus.* 1941.

G. polytrichoides has closer affinities with *G. desertorum* than *G. cucullatus* although it is definitely cortinate as the latter. The

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[2] Singer, R. Studien zur Systematik der Basidiomyceten I. Beih. Bot. Centralbl. **56 Ab. B**: 147–150. 1936. (See p. 149.)

[3] Loc. cit., pp. 148 and 150.

spores of the type species are twice as long as those of this species, as may also be said of the pileus in proportion to its width.

GYROPHRAGMIUM Montagne, Ann. Sci. Nat. II. **20**: 77.   1843.

Syn. *Polyplocium* Berkeley, London Jour. Bot. **2**: 202.   1843.

Fructifications epigeous, stalked; stem percurrent as a columella and continued above as an expanded, cap-like pileus; peridium at first turbinate, then rupturing around the circumference, leaving the lower half as a funnel-shaped volva at the base of the stem and sometimes partially sheathing the latter and the upper part covering the pileus; annulus usually present; gleba suspended from the under surface of the pileus-like expansion of the stem, composed of radial, ventricose, crowded, wavy, sometimes anastomosing lamella, free, at first tough, flexible, at maturity fuscous or black; spores spherical or subsperical, smooth, brownish.

The type species is *Gyrophragmium Delilei* Montagne (1843). Montagne based the genus on *Montagnites Dunalii* Fries (1836) and according to the present International Rules of Botanical Nomenclature undoubtedly the combination for the type species should be **Gyrophragmium Dunalii** (Fries) but doubtless *G. Delilei* Montagne should be conserved.

As indicated above *Polyplocium* is reduced to synonymy with *Gyrophragmium* following the able discussion of this point by Lloyd.[4]   From these notes and Lloyd's illustrations as well as the fragmentary specimens studied from South Africa and North Africa, *G. Delilei* and *G. inquinans* (Berk.) Lloyd are doubtless congeneric but because of spore color, shape, and color of fructifications, the two species can hardly be construed as identical.

A study of the morphological development of the early stages of the fructifications of a species in this genus is much to be desired. It would appear from remnants of fundamental tissues in mature stages that the peridium is double. The outer layer partially or entirely remains at the base of the stem as a volva which is free or more or less sheathing.   Sometimes a portion remains as a partial coating on the upper surface of the pileus, which has rather indefinite origin.   The origin of the annulus, which appears to be

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[4] Lloyd, C. G. *Gyrophragmium* and *Polyplocium*. Mycological Writings **Vol. 1,** Brochure 18 No. **291**: 195–196.   1904.

double in *G. californicum,* is of considerable conjecture. Is it composed of an upper layer (partial veil) extending from the margin of the pileus to the stem and a lower layer which was the extension of the inner peridial layer above the pileus or does its lower portion sheath the stem as an innate superficial layer? A study of the developmental morphology should throw light on such questions and indicate relationships between *Gyrophragmium* and *Longia* and *Montagnea.*

Two species have been named from North America, i.e. *Polyplocium californicum* Harkness and *Gyrophragmium, texense* (Berk. & Curt.) Massee. *P. californicum* Harkness therefore becomes

1. **Gyrophragmium californicum** (Harkness) Morse comb. nov. in Herb. Univ. Calif.

> Syn. *Polyplocium californicum* Harkness, Calif. Acad. Sci. Bull. 1 : 159, 1885.
> *Polyplocium Curranii* Harkness in Herb. N. Y. Bot. Gard.

The following is an emended description of *G. californicum.*

Fructifications tall, slender with a pileus formed from the discoid expansion at the apex of the stem; pileus expanding to flat or depressed, 2–4 cm. broad, covered by remains of the universal veil or peridium, grayish, drying, yellowish to buff or straw-colored; stem 1–1.5 cm. in diam. elongating to 10–20 cm., concolorous; volva at base of stem, white, free, 1–1.5 cm. broad, remains of the ruptured universal veil or outer peridium; annulus sometimes evanescent, sometimes persisting, ample, double, papery above, heavy below, white drying straw-colored; gleba rusty-black, lamelloid, free, suspended from the lower surface of the pileus; spores dark reddish brown smooth, subglobose to irregular, angular to ellipsoid, 6–8.75 × 4–5 μ.

Sandy locations in central California. January to June.

As Lloyd [5] has suggested it is unfortunate that Dr. Harkness did not use the greatest care in distributing his specimens. The specimen at the Berlin Imperial Museum is *Montagnea arenarius* and Hollos [6] cites it as a specimen from Harkness himself and that it

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[5] Loc. cit.

[6] Hollos, Ladislaus. Die Gasteromyceten Ungarns. Leipzig, 1904. (See pp. 30–32 and *T. 1–2.*)

Fig. 1. Left, *Gyrophragmium californicum* (Harkness) Morse (from dried specimens in Univ. Calif. Herb.). Right, the type specimen of *Longia texensis* (Berk. & Curt.) Zeller var. *major* Zeller, × ½ nat. size.

agrees completely with *Montagnites radiosus* (Pall.) Hollos. As cited below the specimens at the New York Botanical Garden and the University of California fit the Harkness description of *G. californicum*.

This species is very limited in its distribution, having been reported only from the area near San Francisco Bay (FIG. 1).

Specimens examined: California: *H. W. Harkness*, Jan., 1882 (in N. Y. Bot. Gard. Herb. under the name *Polyplocium Curranii* Harkn.); San Mateo County, San Francisco, *H. W. Harkness*, May (in N. Y. Bot. Gard. Herb.). Presidio, *Cleone Wetherbee*, April 6, 1929 (in Univ. Calif. Herb. under the name *Gyrophragmium californicum* (Harkn.) Morse).

Gyrophragmium texense (Berk. & Curt.) Mass. is considered not to be congeneric with *Gyrophragmium* as treated above and therefore has been transferred to the following new genus.

Longia gen. nov.

Fructifications agaricoid with stem and capitate peridium; peridium subglobose or depressed globose to broadly convex; surface smooth or rupturing into scales; partial veil leaving a more or less permanent annulus; stem percurrent as a columella, more or less widening above to underlie the upper peridium; gleba black at maturity, lamelliform and variously anastomosing; hymenium of paraphyses and basidia; spores black, subglobose to ellipsoid.

Type species, *Secotium texense*.

The writer is dedicating this new genus to Dr. W. H. Long who has contributed materially to our knowledge of gasteromycetes in the semiarid sections of the southwestern United States.

1. **Longia texensis** (Berk. & Curt.) comb. nov.
    Synonyms:
        Secotium texense Berk. & Curt. Grevillea 2: 34–35. 1873.
        Polyplocium columnare Ellis & Galloway. 1889. in Herb. N. Y. Bot. Gard.
        Gyrophragmium texense (Berk. & Curt.) Massee, Grevillea 19: 96. 1891.
        Polyplocium striatum Ellis & Ev. 1893. in Herb. N. Y. Bot. Gard.

Secotium decipiens Peck, Bull. Torrey Club 22: 492.   1895.
Gyrophragmium decipiens (Peck) Lloyd, Myc. Writ. 1: 62.
    1901.
Podaxon strobilaceous Copeland, Ann. Myc. 2: 4.   1904.

Fructifications agaricoid in form with stem and capitate peridium, 5–12 cm. tall; peridium subglobose or depressed globose to broadly convex, 3–9 cm. broad, 2–7 cm. deep, at first closed below by a "partial veil," rather closely appressed to the stem below, lower part sometimes splitting longitudinally but usually forming a double annulus, the upper part left in the form of a pileus; surface smooth or rupturing into loose or appressed scales, cream- or buff-colored becoming darker (dark warm brown) and sordid grayish at maturity; stem stout, 2–3.5 cm. in diam. below usually tapering upward, abruptly narrowed above into a percurrent columella widening above to underlie the upper pileate peridium, firm becoming woody on drying, solid, internally yellowish or pinkish, externally smooth, usually becoming striate, colored like the peridium; gleba lamelliform to variously united and anastomosing forming irregular cavities, free from the stem, 1–2 cm. deep, ventricose, becoming bone brown to black; hymenium smooth, blackish; basidia broadly clavate, tetrasporous; sterigmata slender, long; spores subglobose to slightly obovoid, sterigmatal scar prominent, smooth, dark brown, 5–6.3 $\times$ 6.2–7.5 μ.

Usually in semiarid, waste places. February to November. Central Texas, westward to San Diego county, California and north to Josephine county, Oregon.

The distinctions between *Gyrophragmium* and *Longia* are very well paralleled by those between *Amanita* and *Lepiota* in the Agaricaceae. *Longia* lacks the persistent universal veil or volva, but is annulate. The gleba or gills are free in all four genera mentioned. *Longia* perhaps provides closer affinities with the smooth-spored members of the Agaricaceae than any other gasteromycete. Barnett [7] who has had opportunity to study all stages of development of the fructifications of *Longia* has shown the close parallelism to the development of certain species of *Agaricus*. Barnett has included good illustrations of *L. texensis*.

[7] Barnett, H. L. The development and structure of *Longia texensis* (in a current issue of MYCOLOGIA).

Specimens examined:

Texas: In mesquite flats, no locality given, *W. H. Long, Jr.* No. 3, 1901 (in N. Y. Bot. Gard. Herb.).   Eastland county, Cisco, *E. A. Smith,* May–June, 1935 (in Zeller Herb.), June 5–10, 1935 (in U. Mich. Herb.), Eastland, *E. A. Smith,* April 8, 12, 20, 23 (2 coll.), 1934, May 6 (2 coll.), 1934; Hudson county, *E. Clover,* No. 806, May 3, 1933 (all in U. Mich. Herb.) ; La Salle county, 105 mi. S.W. of San Antonio (in Farlow Herb.) ; Travis county, Austin, *F. McAllister* (in N. Y. Bot. Gard. Herb), *A. M. Ferguson,* 1902 (in Patouillard Herb. at Farlow Herb., ex. W. H. Long Herb. No. 1825).

New Mexico: Dona Ana county, Las Cruces, *E. O. Wooton,* Feb. 22, 1893 (type of *Polyplocium striatum* E. & E. herb. nom.), Oct., 1893, *F. Garcia,* Apr., 1894 (No. 102, J. B. Ellis) (All in N. Y. Bot. Gard. Herb.), *H. L. Barnett,* during the year, 1941 (in Zeller Herb.).

Oregon: Josephine county, Wilderville, *S. M. Zeller,* July 28, 1941.

California: Central California, *H. W. Harkness,* Apr. to Aug. (Ellis Herb. in N. Y. Bot. Gard. Herb.) ; Butte county, Chico, *L. C. C. Krieger,* Autumn, 1912 (in N. Y. Bot. Gard. Herb.) ; Contra Costa county, Mt. Diablo near Antioch, *H. M. Hall,* Oct. 12, 1918 (in U. Calif. Herb.) ; Fresno county, near Auberry, *W. T. Shaw,* April 18, 1936 (in U. Calif. Herb.) ; Glenn county, Orlando, *Mrs. Bruno Koehler,* Nov., 1924 (in U. Calif. Herb.) ; Los Angeles county, Claremont, *C. F. Baker,* June, 1914 (in N. Y. Bot. Gard. Herb.), Lamanada Park, *E. A. Bonine,* May, 1897 (in N. Y. Bot. Gard. Herb.), Palmdale, *Ann Frey,* May 5, 1940 (in U. Calif. Herb.), Pasadena, *L. N. Gardner,* April, 1908 (in U. Calif. Herb.), *A. J. McClutchie,* Nov., 1894 (comm. by A. P. Morgan to N. Y. Bot. Gard. Herb., Dec., 1894) ; Orange county, Santa Ana, *Miss Geis,* Apr., 1902 (in N. Y. Bot. Gard. Herb.), Plumas county, Quincy, *D. L. Burdick,* July, 1933 (in U. Calif. Herb.), Riverside county, Riverside, *C. O. Smith,* Jan. 15, 1935 (in U. Calif. Herb.) ; San Benito county, Pinnacles National Monument, *Nick McKibben,* May 7, 1939 (in U. Calif. Herb.) ; San Bernardino county, Mentone, *W. I. Teuch,* May 9, 1900 (in U. Calif. Herb.), Rattlesnake Canyon, *Mrs. C. P. Krauth,* Feb.,

1934 (in U. Calif. Herb.) ; San Diego county, Imperial Beach, *Dr. E. A. Purer,* Mar. 26, 1938 (in U. Calif. Herb.), San Diego, *C. B. Orcutt,* March, 1889 (type of *Polyplocium columnare* Ell. & Galw. herb. nom. in N. Y. Bot. Gard. Herb.) ; Solano county, Davis, *F. H. Bolster,* Jan., 1912 (in U. Calif. Herb.) ; Stanislaus county, Blakesley Beach, Empire, *E. E. Morse,* June, 1939 (in U. Calif. Herb.).

Longia texensis var. **major** var. nov.

Fructifications large, 15–30 cm. tall, tan to grayish; stems bulbose, 5–7 cm. in diam. at the base when fresh, drying 3–4.5 cm. below and 2.5–3.5 cm. above, smooth, sometimes scaly, wrinkled but not striate when dry, sometimes with reddish brown streaks, solid; annulus usually persistent, normally superior; peridium subglobose to expanded 6–12 cm. broad, 3–6 cm. deep, quite smooth to areolate when young, with large scales at maturity; gleba and spores as in species.

In semiarid locations. April to September. Distribution: From Yolo county, California, south into northern Mexico.

This is the large Pacific Coast plant to which Lloyd referred under *Gyrophragmium decipiens* as "much more obese . . . with a thick stem" (Myc. Writ. 1: 196. 1904) and beautifully illustrated in his pl. 23, fig. 1.

This is in contrast to *Longia texensis* itself which he illustrated in pl. 23, figs. 2 and 3 and in pl. 24, fig. 5. When the latter grows in the margins of cultivated, and especially irrigated, areas it attains larger size than in its usual arid or semiarid habitat, but variety *major* is distinctly larger even under semiarid conditions. The cap is more conspicuously scaly at maturity than the species (FIG. 2).

Specimens examined:

Mexico: Baja California, Zaragora, *C. B. Orcutt,* April, 1889 (in Zeller Herb., comm. by C. G. Lloyd).

California: *A. J. McClatchie,* no further data (in N. Y. Bot. Gard. Herb.) ; Kern county, Wasco, *Mrs. Emma S. Keese,* April 29, 1932 (in U. Calif. Herb.) ; Los Angeles county, near Lancaster, *Richard Greer,* April 24, 1940 (in U. Calif. Herb.) ; Solano county, Davis, *F. H. Bolster,* June and Sept., 1912 (U. Calif. Herb.) ; Yolo county, Woodland, *Eugene Brauner,* April 21, 1940, *type* (in U. Calif. Herb.).

MONTAGNEA Fries, Genera Hymenomycetum p. 7.   (April) 1836;
not Montagnaea DC.

Syn.
  Montagnea Fries, in litt.   1833.
  Montagnites Fries, Epicrisis p. 240.   1836.

Fructifications, stipitate, with general *Coprinus*-like appearance;
peridium remaining as a volva at the base of the stipe; stem ex-
panded at apex into a flattish disk, from the margin of which fall
radially the free (not anastomosing), nude, persistent (not deli-
quescent), lamelloid gleba; spores smooth, dark fuscous, black *en
masse,* borne acrogenously.

Fries first published *Montagnea* in his "Genera Hymenomyce-
tum," April, 1936, and later changed the name to *Montagnites* in
the Epicrisis to make way for DeCandolle's *Montagnaea* which was
a renaming of a genus, *Montañoa,* in the Compositae.   *Montagnaea*
was not published until October, 1936, and at any rate is regarded
as invalid by the phanerogamic taxonomists (see Kew Index).
These circumstances give the name *Montagnea* Fries clear standing,
both on the basis of different spelling and from priority, against
Montagnaea DC.   *Montagnea* is a more desirable name for, ac-
cording to the nomenclatorial system now generally recognized,
Montagnites could more appropriately represent a fossil genus.
Montagne [8] emended Fries' description of *Montagnea* and indicated
there was no legitimate reason for the name *Montagnites.*

The type species is *M. arenarius* (DC.) since *Montagnites Du-
nalii,* listed first by Fries, belongs in Montagne's genus, *Gyrophrag-
mium.*

1. **Montagnea arenarius** (DC.) comb. nov.
    Syn. *Agaricus (Boletus) radiosus* Pallas. Russ. Reis 2.
         p. 744.   1777.
         Agaricus arenarius DC.   Flore Francaise 6: 45.   1815.
         Montagnites Candollei Fries, Epicrisis p. 241.   1836.
         Montagnites Pallasii Fries, Epicrisis p. 241.   1836.

Fructifications 8–30 cm. tall, *Coprinus*-like in general appearance;
pileus merely an expanded disk of the summit of the columella

[8] Montagne, J. F. C. Sylloge generum specierumque cryptogamarum.
Paris, 1861. (See pp. 129–130.)

(stem), 1–3.5 cm. broad, tapered to a very thin edge, convex then plane to depressed, surface smooth, white or grayish, usually with remnants of the volva at the center and sometimes extending nearly to the margin; gleba lamelloid, entirely free from the main columella, attached to the margin of the discoid pileus, ventricos rounded below; lamella crowded, ventricose-rounded, black, of light fuscus hyphae, 1–3.5 cm. long, 4–12 mm. broad; columella-stipe 8–30 cm. long, 4–26 mm. in diam. above usually tapering downward, hollow, white fleshed, becoming almost woody on drying, surface smooth to striate, often becoming scaly or lacerate, white or whitish; volva usually double, the outer white more or less ample, usually covered with adherent sand, the inner lacerate, of tough fibrous strands; paraphyses broadly clavate, somewhat fuscus; basidia clavate or pyriform, somewhat fuscus, 4-spored, almost square at the distal end with blunt sterigmata at the corners, so to speak, 20–28 $\times$ 10–14 μ; spores almost sessile, borne acrogenously, dark fuscus with a more or less hyaline germ pore at the distal end, ellipsoid to obovoid, 12–19 $\times$ 6–11.2 μ.

This species as the name implies grows in sandy places, usually in the open sunlight. The plants are scattered or gregarious. Whole fields of thousands of specimens have been reported in eastern Oregon. Usually the stipe is about one-half to two-thirds buried in the sand. If the specimens are pulled up the volva is usually left in the ground.

The double volva is rather inconspicuous in some specimens. The inner portion is very lacerate and has some characteristics of columella (stem) tissue. A study of the developmental morphology through the young stages of the sporophore is needed to aid in an interpretation of origin of these fundamental tissues.

This one American species is extremely variable in stature according to the conditions under which it may be found. An attempt, however, to segregate slender growth forms which may be classed as approaching *M. tenuis* Pat. fails when the whole morphological picture is considered. Specimens from sandy dune-like ridges high up on the north side of Mt. Shasta, California, are small and rather slender, actually about 6–14 cm. tall. Nevertheless they do not attain the gracility or appearance of *M. tenuis*. From the broad, dry, plateau-like expanses of eastern Oregon or lower altitudes of California the specimens are intermediate in size, while in the southern range of *M. arenarius,* in Texas, New Mex-

ico, Arizona, and southern California, the fungus attains its greatest stature, with a stem up to a height of 25–30 cm., and diameter proportionate, up to 2.6 cm. above, tapering downward. But along with these larger specimens, however, will be smaller ones similar to those found in the northern range of distribution.

Mention should be made here of the very conservative attitude of Hollos [9] who has included practically all described species under his *Montagnites radiosus.* For instance, *M. Elliotti* Mass. which was discovered by Scott-Elliott in the Nile Valley, Egypt (*not* "New Zealand" as erroneously stated in Sacc. Syll. Fung. **11**: 79 and copied by Hollos and others), is a species distinct and apart from *M. arenarius.* The stem tissues are distinct, composed of silky longitudinal fibers not like those in *M. arenarius.* The spores in the type of *M. Elliotti* (in N. Y. Bot. Gard. Herb.) are ovate and 6–7.75 $\times$ 4.5–5.μ, instead of "12 $\times$ 7" as described by Massee (Grevillea **11**: 1. 1892). Hollos has also included here *Polyplocium californicum* Harkness, which has already been discussed under *Gyrophragmium,* and *M. tenuis* Pat. The latter seems quite distinct from *M. arenarius* if Patouillard's description is accurate and it doubtless is, for specimens from the Galapagos Islands (in U. of Calif. Herb.) correspond to his description. In these the spores are ellipsoid, obovoid or angular, with thick rather clear walls, and measure 5–6.5 $\times$ 4–4.5 μ.

Specimens examined:

Texas: *W. H. Long,* No. 4, 1901, no data (in Herb. N. Y. Bot. Gard.) ; Travis County, Austin, *W. H. Long,* No. 317, 1901 (in Farlow herb. under the name *Montagnites texensis* Berk.).

New Mexico: Bernalillo county, Albuquerque, *W. H. Long,* Feb. 4, 1933 (in Herb. U. Calif.) and No. 10256, May, 1942 (in Zeller Herb.) ; Dona Ana county, Mersilla, *H. L. Barnett,* Aug., 1938 (in Zeller Herb.).

Arizona: Navajo county, Oraibi-Leupp road, *A. F. Whiting,* Aug. 24, 1936 (in Herb. Mus. N. Ariz. No. 814/2615, also in Herb. U. Mich.).

Oregon: Crook county, 6 miles E. of Redmond, *Max Doty,* May 5, 1938 (in Zeller Herb.) ; Deschutes county, *S. M. Zeller,* June 23,

[9] Loc. cit. (See pp. 30–32 and *T. 1–2.*)

1929; Grant county, *R. E. Brooke,* May 27, 1940 (in Zeller Herb.).

California: Southern Calif., *A. J. McClutchie,* no data (in Herb. N. Y. Bot. Gard.); Los Angeles county, Dry Lake near Lancaster, *H. E. Bailey,* Apr. 3, 1942 (in Herb. U. Calif.); Riverside county, Elsinore, *A. J. McClutchie,* Mar. 28, 1896 (in Herb. N. Y. Bot. Gard.), *Mr. and Mrs. T. S. Brandegee* (in Zeller Herb.), Riverside, *C. O. Smith,* Mar. 26, 1937 (in Herb. U. Calif.); San Bernardino county, Forest Home, *H. K. Rusby,* Sept., 1909 (in Herb. N. Y. Bot. Gard.), *Kramer, T. S.* and *K. L. Brandegee,* May, 1914 (in Herbs. U. Calif. et N. Y. Bot. Gard.), Mohave Desert, *H. W. Harkness,* June, and San Bernardino, *John A. Anderson,* 1940 (both in Herb. N. Y. Bot. Gard.).

Mexico: Baja California, El Alamo, *James McMurphy* & *Wiggins,* April 28, 1931 (No. 46) (in Zeller Herb. and Lloyd collections).

U. S. S. R. (Russia): Transcaucasia, Elizavetopol, *G. Woronow,* No. 30 (Fungi Caucasici, in Herb. N. Y. Bot. Gard.).

Africa: Algeria, *Trabut,* July, 1908 (in Herb. Patouillard at Farlow Herb., Harvard U.).

Nearly all specimens cited above are accessioned in herbaria under the name *Montagnites Candollei* Fries.

OREGON STATE COLLEGE,
CORVALLIS, OREGON

SOME SOUTHERN NOVELTIES

WILLIAM A. MURRILL

The specimens cited in this paper, belonging to various groups of fleshy fungi, are deposited in the herbarium of the Florida Agricultural Experiment Station, at Gainesville.

Armillaria floridana sp. nov.

Pileo convexo-plano, 4.5 cm. lato, glabro, umbrino-isabellino; sporis sub-globosis, hyalinis, 4 μ; stipite albo, 3 × 0.7–0.9 cm., annulo albo, parvo.

Pileus convex to plane and finally slightly depressed, not umbonate, 4.5 cm. broad; surface somewhat viscid, uneven, glabrous, uniformly umbrinous-isabelline or slightly darker on the disk, margin even, undulate; context white, unchanging, odor faint and pleasant; lamellae deeply emarginate, just touching the stipe, broad, ventricose, rather close, inserted, entire, fragile, white, isabelline when dry; spores subglobose, smooth, hyaline, uniguttulate, about 4 μ; stipe subfusiform, not bulbous, white, smooth, dry and glabrous above the annulus, viscid and floccose-squamulose below, about 3 × 0.7–0.9 cm.; annullus median, small, white, persistent.

Type collected by W. A. Murrill in humus under an oak at Gainesville, Fla., July 7, 1938 (*F 17467*). Only two hymenophores were found, growing a few inches apart. They suggested nothing with which I am acquainted, either in *Armillaria* or *Lepiota*. No cystidia of any kind were seen and the spores are not amyloid. Dr. Singer would probably refer the species to *Limacella*.

Armillaria graveolens sp. nov.

Pileo convexo-plano, 4–6 cm. lato, glabro, viscido, isabellino, nauseoso, margine appendiculato; sporis globosis, albis, 6.5 μ; stipite albo, glabro, 4–6 × 0.5–1 cm.; annulo parvo, fibroso, albo.

Pileus convex to plane, scattered, 4–6 cm. broad; surface distinctly viscid, glabrous, uneven, isabelline, somewhat darker on the disk; margin projecting, decidedly appendiculate; context soft, white, unchanging, taste very farinaceous, odor strong, earthy-farinaceous; lamellae adnexed, narrow, crowded, inserted, soft, en-

tire, milk-white, unchanging; spores globose, smooth, hyaline, granular, about 6.5 μ; stipe fleshy, solid, equal or slightly tapering upward, not at all viscid, not separating, smooth, white and glabrous above, scurfy near the base with rosy-isabelline remains of the veil, 4–6 × 0.5–1 cm.; veil mostly breaking up, leaving a double ring-trace near the base of the stipe.

Type collected by W. A. Murrill in moist, sandy soil under a camphor tree in Gainesville, Fla., July 27, 1941 (*F 21435*). The objectionable odor was distinct in the open air and became almost unbearable in a closed room, suggesting a shock of rotting wheat. No cystidia were observed and the spores are not amyloid. According to Dr. Singer's classification the species would probably go into *Limacella*.

Armillaria raphanica sp. nov.

Pileo convexo-expanso, gregario, 5–7 cm. lato, glabro, rosei-isabellino, appendiculato, raphanico; lamellis adnatis, angustibus, confertis, albis, sporis oblongo-ellipsoideis, 5 × 2 μ; stipite albo, fibrilloso-squamuloso, 3–5 × 0.4–0.6 cm.

Pileus convex to expanded, slightly depressed at times, gregarious to subcespitose, 5–7 cm. broad; surface smooth, glabrous, rosy-isabelline, a little darker at the center, margin incurved, even, entire, appendiculate; context very thin, white, unchanging, not fragile, odorless when fresh, with the taste of radishes; lamellae adnate, seceding, very narrow and very close, entire, some inserted and a few forked, white or pallid; spores oblong-ellipsoid, obliquely apiculate, smooth, hyaline, about 5 × 2 μ; stipe tapering downward, solid, cartilaginous to subligneous, fibrillose-squamulose, white throughout or brownish below, 3–5 × 0.4–0.6 cm.; veil evanescent, leaving no annulus.

Type collected by E. West and W. A. Murrill on a hardwood log in Sanchez Hammock, near Gainesville, Fla., July 23, 1938 (*F 17949*). Suggesting *A. Boryana* (Berk. & Mont.) Murrill but differing in closer, narrower gills, etc. In the drying oven the odor of radishes becomes very pronounced. According to the latest classification species of the old genus *Armillaria* are scattered among several genera. This one, with its non-amyloid, cylindric, smooth spores and no cystidia would be placed by some in the genus *Lentinus*.

Camarophyllus translucens sp. nov.

Pileo umbilicato, albo, 1 cm. lato; lamellis decurrentibus, praedistantibus, albis; sporis subglobosis, 5 μ, stipite albo, 1.5 × 0.15 cm.

Pileus umbilicate, gregarious, 1 cm. broad; surface moist but not viscid, smooth, glabrous, white, translucent, showing the gills, margin deflexed, entire; context membranous, subhyaline, odorless; lamellae decurrent, few, distant, broad, inserted, entire, white; spores subglobose, smooth, hyaline, 5 μ; cystidia none; stipe subequal, smooth, glabrous, white, translucent, 1.5 × 0.15 cm.

Type collected by W. A. Murrill in moist earth under hardwood trees in Planera Hammock, eleven miles northwest of Gainesville, Fla., August 13, 1938 (*F 18045*). A small, dainty species, very virginal in appearance.

Cortinellus subdecorosus sp. nov.

Pileo convexo ad depresso-subumbonato, 3.5 cm. lato, fulvo, praespinuloso; sporis 4–5 μ, cystidiis praemagnis; stipite glabro, 4 × 0.4 cm.

Pileus convex to slightly depressed, gregarious, 3.5 cm. broad; surface dry, fulvous, slightly darker on the small umbo, densely adorned with long, slender spines; margin even, lobed; context thin, white, mild; lamellae sinuate, close, narrow, inserted, pallid, beautifully fringed; spores subglobose to broadly ellipsoid, smooth, hyaline, obliquely apiculate, uniguttulate, 4–5 μ long; cystidia on edges of gills enormous, subcylindric to ten-pin shape, smooth, hyaline, about 20 μ thick and projecting 40–45 μ; stipe pale-isabelline, smooth, equal, pruinose at the apex, glabrous below, 4 × 0.4 cm.

Type collected by West and Murrill on a hardwood log in wet ground in Sugarfoot Hammock, near Gainesville, Fla., August 4, 1938 (*F 18052*). Suggesting *C. decorosus* (Peck) Murrill but having a glabrous stem and other distinctive characters. The marginal cystidia are quite impressive.

Cortinellus totilividus sp. nov.

Pileo convexo-expanso, 6–8 cm. lato, hirto-tomentoso, livido; lamellis sinuatis, lividis; sporis ovoideis, 5–6 × 4 μ; cystidiis fusoideis, lividis; stipite hirto-tomentoso, livido, 5 × 1.5 cm.

Pileus convex to expanded, slightly depressed, gregarious or cespitose, 6–8 cm. broad; surface dry, hirtose-tomentose, uniformly

lividous, margin even, entire to slightly lobed; context white, unchanging, odorless, mild; lamellae sinuate, broad behind, inserted, rather crowded, entire, lividous; spores ovoid, smooth, hyaline, 1-guttulate, about $5-6 \times 4\,\mu$; cystidia plentiful, fusoid, lividous, about $15\,\mu$ thick at the middle, projecting about $40\,\mu$; stipe swollen below, colored and clothed like the pileus, yellow within, about 5×1.5 cm.

Type collected by W. A. Murrill on moist humus in a low hammock at Juniper Springs, Marion Co., Fla., Sept. 17, 1939 (*F 18745*). A very striking hymenophore, brilliantly colored, with large livid cystidia visible through a hand-lens. With age and on drying the surface of both cap and stem usually shows isabelline or umbrinous tints.

Geopetalum suballiaceum sp. nov.

Pileo dimidiato, 2–2.5 cm. lato, albo; lamellis distantibus, albis, sporis $6-7 \times 4\,\mu$, cystidiis fusoideis, $60-75 \times 15\,\mu$.

Pileus dimidiate or flabelliform, attached by a narrow base, gregarious, 2–2.5 cm. broad; surface smooth, slightly pruinose behind, whitish, opaque, becoming slightly yellowish on drying and striate over the lamellae, margin often lobed; context membranous, white, odorless; lamellae distant, inserted, white, entire, yellowish with a brownish tint when dry; spores ellipsoid or ovoid, smooth, hyaline, about $6-7 \times 4\,\mu$; cystidia oblong-fusoid with short stalk and acute or blunt tip, hyaline, about $60-75 \times 15\,\mu$.

Type collected by W. A. Murrill on a much-decayed hardwood log in a high hammock at Gainesville, Fla., July 1, 1938 (*F 17310*). The flesh is so thin that the gills show through when dried. The cystidia are much like those found in *G. petaloides* (Bull.) Pat.

Gymnopus alliaceus sp. nov.

Pileo convexo, 6–8 cm. lato, pallido, alliaceo; lamellis adnatis, angustatis, sporis ellipsoideis, $5-6 \times 4\,\mu$; stipite excentrico, pallido, $2-3 \times 0.3-1$ cm.

Pileus subcircular, convex, gregarious, 6–8 cm. broad; surface opaque, smooth, glabrous, pallid or rosy-isabelline, margin even, often lobed; context thin, whitish, with a strong odor of onions and a distinct taste of radishes; lamellae adnate, seceding, arcuate, narrow, crowded, entire, pallid to rosy-isabelline; spores broadly ellipsoid, smooth, hyaline, uniguttulate, $5-6 \times 4\,\mu$; cystidia none;

stipe eccentric, curved, tough to almost woody, tomentose, enlarged
and striate above, white or rosy-isabelline, solid, scaly below, 2–3 ×
0.3–1 cm.

Type collected by W. A. Murrill on the side of a rotten oak log
in a low hammock at Magnesia Springs, Fla., August 15, 1938
(*F 17940*). The odor develops as the hymenophore begins to
dry. The eccentric stipe may be due to its position on the log.

Lentodium floridanum sp. nov.

Pileo depresso, squamuloso, 2–3.5 cm. lato; lamellis adnatis, confertis,
albis; sporis ellipsoideis, 5 × 3 μ; stipite floccoso-squamuloso, 1.5 × 0.3–0.5
cm.; velo appendiculato, parvo.

Pileus subcircular or irregular, convex to depressed, at times
umbilicate, gregarious, 2–3.5 cm. broad; surface dry, squamulose,
white with bay disk and bay, pointed scales, margin pallid, even,
lobed; context very thin, white, unchanging; lamellae squarely
adnate, close, narrow, white, entire to slightly undulate or notched;
spores ellipsoid, smooth, hyaline, usually 1-guttulate, about 5 × 3 μ;
stipe tapering downward, solid, floccose-squamulose, white above,
bay below, 1.5 × 0.3–0.5 cm.; veil slight, remaining in fragments
on the margin but not forming an annulus.

Type collected by W. A. Murrill on a hardwood log in Beech
Woods, near Santa Fé, Alachua Co., Fla., July 13, 1938 (*F 17876*).
Found but once.

Limacella roseola sp. nov.

Pileo umbonato, 5 cm. lato, roseo; lamellis pallide-roseis; sporis sub-
globosis, hyalinis, 6–7 × 5–6 μ; stipite pallide-roseo, 7 cm. longo; annulo
medio.

Pileus convex to expanded, umbonate, solitary, about 5 cm.
broad; surface smooth, glabrous, rose-pink, slightly darker roseous
on the umbo, margin even, entire; lamellae rose-tinted, just touch-
ing the stipe, rather broad and crowded, entire; spores subglobose,
smooth, hyaline, 6–7 × 5–6 μ; stipe slender, tapering upward,
smooth, subglabrous, pale-roseous, about · 7 cm. long; annulus
median, evanescent.

Type collected by W. A. Murrill in humus in a hollow tree at
Lynchburg, Va., Sept. 16, 1926 (*F 16061*). A very beautiful spe-
cies, found only once. The texture is soft and the pileus of light

weight but the stem is solid. The spores were measured by Mr. West. Dr. Singer thinks they are 3.8–5 × 3.2–3.8 μ. There are minute droplets inside the wall whose refraction gives a rough or reticulate appearance, as occurs at times in *L. illinita*. The walls of the cuticular hyphae are slightly gelatinous in KOH solution.

Marasmiellus Violae sp. nov.

Pileo subcirculari, convexo, 1–2 mm. lato, albo, margine incurvo; lamellis adnatis, distantibus, albis; stipite eccentrico, albo, 0.5 mm. longo.

Pileus irregularly circular, convex to subexpanded, 1–2 mm. broad; surface finely pubescent, white, margin even, entire, incurved; context membranous, white; lamellae adnate, few, distant, narrow, inserted, white, edges thick, entire; stipe eccentric, curved, subequal, slender, subglabrous, white, about 0.5 mm. long.

Type collected by W. A. Murrill on the under side of green leaves of *Viola villosa* in Gainesville, Fla., July 25, 1939 (*F 19742*). Evidently parasitic and not associated with *Cercospora Violae*, which is common on this host. The cap of this dainty little agaric presses closely against the lower surface of the leaf. The nearest relative is probably *M. inconspicuus* Murrill, described from Cuba. Although satisfactory spore characters have not been obtained I think it best to publish the species so that others may be on the lookout for it.

Venenarius odoriferus sp. nov.

Pileo convexo-plano, 10–14 cm. lato, floccoso-squamuloso, albo; sporis ellipsoideis, 7–10 × 5–7 μ; stipite albo, globoso-bulboso, 8–14 × 1–2 cm.; volva veloque evanescentibus.

Pileus convex to plane, gregarious, 10–14 cm. broad; surface white, densely covered with small, erect, floccose squamules, margin entire, even; context white, with a peculiar, penetrating, rather pleasant odor, which becomes stronger and persists in dried specimens; lamellae adnexed, medium distant, rather narrow, inserted, white, edges slightly fringed; spores oblong-ellipsoid, smooth, hyaline, granular, 7–10 × 5–7 μ; stipe equal and 8–14 × 1–2 cm. above the bulb, white, clothed like the pileus; bulb globose, not radicate, 3–5 cm. thick; volva breaking up and leaving no limb; veil clinging for a time to the margin of the pileus in large, white, membranous fragments, leaving no annulus.

Type collected by West, Arnold and Murrill on the ground in dry oak-pine woods at Sugarfoot, near Gainesville, Fla., July 11, 1938 (*F 17684*). Also collected by W. A. Murrill in mixed woods of loblolly pine and turkey oak at Gainesville, June 10, 1938 (*F 17656*); and under a live-oak, July 6, 1938 (*F 17683*). A very handsome species, resembling *V. solitarius* but having a dense, uniform covering of small scales instead of sharp warts and an odor unlike that of any other fungus known to me. It has no resemblance to chloride of lime but suggests some faintly scented soap or freshly-steamed bone slightly flavored with caramel. This odor persists for several years in the herbarium.

Venenarius submutabilis sp. nov.

Pileo convexo-plano, 6–10 cm. lato, albo, rubescente; lamellis latis, sporis 10–12 × 5–6 μ; stipite albo, bulboso, 8–13 × 1.5–2 cm.; annulo amplo, volva lobata.

Hymenophore white throughout, all parts changing in 2–5 minutes when cut or bruised to roseous and later to subincarnate, fading back to white within an hour. Pileus convex to plane, usually with a few flat volval fragments, scattered, 6–10 cm. broad; surface dry, smooth, margin entire, even; context odorless or smelling faintly of anise; lamellae free or adnexed, ventricose, rounded behind, inserted, medium distant, broad, entire; spores oblong-ellipsoid, smooth, hyaline, granular, 10–12 × 5–6 μ; stipe equal above the bulb, mostly hollow, glabrous and finely ridged at the apex, fibrillose below, 8–13 × 1.5–2 cm.; annulus ample, skirt-like, fixed 0.5–2 cm. from the apex; bulb globose to ovoid, 3–5 × 3–4 cm.; volva cuplike, ample, white, persistent, with free, lobed margin.

Type collected by W. A. Murrill in a high hammock at Burnett's Lake, Alachua Co., Fla., Sep. 24, 1941 (*F 20004*). Also collected several times in the vicinity of Gainesville, both under oaks and pines. Differing from *V. anisatus* Murrill in changing color and from *A. mutabilis* Beardslee in its smaller spores and lobed volva.

CHAMAEOTA MAMMILLATA (Longyear) Murrill

Pileus convex to nearly plane, not umbonate, cespitose, about 5 cm. broad; surface dry, scabrous, especially in the center, neither

rugose nor striate, colored a beautiful yellow with an orange tint; context very thin, pale yellowish; lamellae free, ventricose, crowded, pale rose-pink; spores salmon-colored in mass, subglobose, smooth, $6-7\,\mu$; stipe slender, tapering upward, white with a faint yellowish tint, about 5 cm. long; annulus median, fixed, persistent, ample, pale-yellow.

Previously known only from Michigan. The specimens above described, which are deposited in the herbarium at Gainesville, were collected by the author on dead wood in deciduous woods at Lynchburg, Va., Sept. 3, 1926. These notes on the fresh specimens will be seen to differ in several particulars from descriptions previously published of this interesting species. In 1938 four collections were made of it on dead hardwood near Gainesville, Fla.

Claudopus cyaneus sp. nov.

Pileo dimidiato, 1.5–2 cm. lato, cyaneo; lamellis subcoeruleis, sporis angulatis, $10 \times 6\,\mu$; stipite excentrico, minuto, albo.

Pileus dimidiate, conchate, gregarious, 1.5–2 cm. broad; surface smooth, finely tomentose, especially behind, uniformly cyaneous, margin even, entire or lobed; context very thin, pallid, odor and taste decidedly farinaceous; lamellae adnate, broad behind, inserted, subdistant, entire, pale coeruleous, soon becoming pink; spores very angular, 1–2-guttulate, pink, about $10 \times 6\,\mu$; stipe very eccentric, curved, short, white, tomentose, about 3×1.5 mm.

Type collected by E. West, Lillian Arnold and W. A. Murrill on hardwood logs in Planera Hammock, eleven miles northwest of Gainesville, Fla., July 16, 1938 (*F 17841*). This dainty, dark-blue species with angular spores, first discovered by Miss Arnold, could hardly be confused with anything else. I consider it an outstanding addition to the fungous flora of Alachua County.

Lepista panaeoliformis sp. nov.

Pileo convexo-expanso, 5–8 cm. lato, subhispido, atriavellaneo, sapore grato; lamellis sinuatis, albis; sporis ellipsoideis, subroseis, $6-7 \times 3-4\,\mu$; stipite solido, albo, glabro, $3-4 \times 1-1.5$ cm.

Pileus convex to subexpanded, often gibbous, gregarious, 5–8 cm. broad; surface dry, smooth, uniformly dark avellaneous, with minute concolorous tufts of fibrils more persistent on the disk,

margin incurved, sterile, even, entire to undulate or at times lobed; context thick, soft, whitish, unchanging, sweet and nutty with anise odor; lamellae sinuate, crowded, rather narrow, broadest behind, inserted, white to pale pink, entire to undulate or notched; spores ellipsoid, smooth, 1-guttulate, dull pink in mass, $6-7 \times 3-4 \mu$; cystidia none; stipe solid, fleshy, equal or enlarged below, smooth, glabrous, milk-white, unchanging, $3-4 \times 1-1.5$ cm.

Type collected by W. A. Murrill in shaded leaf-mold by a bay-head in Gainesville, Fla., Oct. 7, 1942 (*F 15722*). Very shapely and attractive; probably edible. Not found elsewhere.

Pluteus floridanus sp. nov.

Pileo convexo-subexpanso, umbonato, 2 cm. lato, squamuloso, striato, nigro-fuliginoso; sporis globosis, 4.5–5 μ, cystidiis obtusis, $30 \times 10 \mu$, stipite er-mineo, 3×0.1–0.2 cm.

Pileus convex to subexpanded, with a small umbo, solitary, 2 cm. broad; surface dry, squamulose, long-rimose-striate, shining blackish-fuliginous; context thin, white, unchanging; lamellae remote, medium broad, crowded, ventricose, inserted, entire, soon becoming pink; spores copious, globose, smooth, pink, uniguttulate, 4.5–5 μ; cystidia abundant, flask-shaped, smooth, hyaline, obtuse, about 10–15 μ thick and projecting about 30 μ; stipe tapering upward, shining satiny-white, smooth, glabrous, 3×0.1–0.2 cm.

Type collected by W. A. Murrill on a rotten hardwood log in woods at Gainesville, Fla., July 7, 1938 (*F 17469*). An attractive species, with shining-black, long-striate cap, satiny-white stem, and very regular, globose spores measuring not over 5 μ. The large hyaline cystidia may be seen in abundance with a hand-lens on the sides of the fresh gills.

Crepidotus amarus sp. nov.

Pileo convexo, reniformi, 5–8 mm. lato, albo, amaro; lamellis distantibus, albis ad fulvis, sporis $5-7 \times 4-5 \mu$; stipite eccentrico, brevi, albo.

Pileus reniform or subcircular, convex, not resupinate at first, gregarious, 5–8 mm. broad; surface uniformly white, unchanging, pulverulent, margin entire, slightly striate at times; context thin, white, very bitter at once; lamellae adnexed, broad at the base, distant, inserted, whitish with beaded, fimbriate edge, becoming fulvous with white edge; spores ellipsoid or ovoid, smooth, pale

yellowish-brown, many uniguttulate, 5–7 × 4–5 μ; stipe always present, eccentric, short, slender, curved, white.

Type collected by W. A. Murrill on a dead grapevine stem in a high hammock at Gainesville, Fla., June 28, 1938 (*F 17226*). Noteworthy because of its small size, its bitter taste, and its small, curved stipe. The very youngest hymenophores showed no tendency toward being resupinate. The spores are perfectly smooth.

Naucoria semiorbicularis lacunosa var. nov.

Pileo convexo, 2–3 cm. lato, glabro, cremeo, praelacunoso, farinaceo; stipite 3–4 × 0.3 cm.

Pileus convex, gregarious, 2–3 cm. broad; surface glabrous, cremeous, conspicuously and deeply pitted except at the very center; context farinaceous; stipe pallid above, cremeous below, 3–4 × 0.3 cm.

Type collected by W. A. Murrill on an exposed lawn in Gainesville, Florida, July 26, 1938 (*F 17958*). In a large collection of hymenophores every cap was deeply pitted; even the young ones only a few millimeters in diameter. No trace of a veil was observed. The spores were typical for the species, having a purplish tint in mass suggestive of *Stropharia*. This variety is very common about Gainesville and is always distinctive.

Coprinus praemagnus sp. nov.

Pileo cylindrico ad subcampanulato, 10 × 7 cm., albo, squamuloso, striato; lamellis confertis, angustatis, albis; sporis ovoideis, 15–18 × 8–10 μ; cystidiis 65 × 12 μ; stipite cylindrico, glabro, albo, praeradicato, 8 × 2 cm.; annulo parvo, albo, persistente.

Pileus cylindric to subcampanulate, solitary, 10 × 7 cm.; surface white, finely striate, with a few small reflexed scales, margin entire; context thin, white, odorless, with nutty flavor; lamellae narrow, crowded, white at first, at length becoming black and melting away; spores ovoid, smooth, black, truncate, granular, about 15–18 × 8–10 μ; cystidia narrowly flask-shaped with tapering neck, hyaline, about 65 × 12 μ; stipe equal, smooth, glabrous, white, long-radicate, 8 × 2 cm.; root 7 cm.; annulus small, persistent, fixed 2 cm. above the base of the stipe.

Type collected by W. A. Murrill in leaf-mold in a high hammock on the Newberry Road, seven miles west of Gainesville, Florida, Jan. 4, 1940 (*F 19294*).   The largest species we have, measuring a foot in height, counting the root.   It is evidently a wild woodland type unassociated with cultivated land or manure heaps.   This spot was carefully watched by Mr. J. R. Watson and myself for three years without finding additional hymenophores.   However, another collection was made several miles distant in March, 1942.   The species resembles *C. comatus* in some ways but is larger and occurs in a different habitat.

Gomphidius foliiporus sp. nov.

Pileo convexo-plano, 6–7.5 cm. lato, subtomentoso, testaceo-fulvo; lamellis decurrentibus, sporis fusoideis, $12 \times 5 \mu$; stipite tomentoso, subconcolori, 3–5 × 0.6–1 cm.

Pileus circular, convex to plane or slightly depressed, solitary or gregarious, 6–7.5 cm. broad; surface dry, smooth, subtomentose, uniformly testaceous-fulvous, sometimes with bay center in age; margin even, entire, hispid-tomentose, dark-blue where bruised; context 1–2 cm. thick, odorless, sweet and nutty, pallid, slightly bluish when cut; lamellae decurrent, broad, inserted, subdistant, entire, often anastomosing to form large pores, pallid, dark-blue when bruised, at length dark-brown; spores boat-shaped, smooth, pale-umbrinous, umbrinous or purplish-brown in mass, about $12 \times 5 \mu$; cystidia none; stipe central, equal, solid, striate, dry, tomentose, pale testaceous or yellowish-white, often fulvous below, 3–5 × 0.6–1 cm.

Type collected by E. West, L. Arnold and W. A. Murrill under an oak in Sugarfoot Hammock, near Gainesville, Fla., July 11, 1938 (*F 17747*).   Also collected the next day near the same place by the same persons on a rotten pine stump under oaks (*F 17774*), and the day following in soil under a pine (*F 17775*).

This species is one of those puzzles that cause loss of sleep. When first sighted I thought of *Stropharia*, but the gills were too decurrent.   Although showing kinship with *Phylloporus* and *Paxillus*, the spores were far too dark.   I am placing it with *Gomphidius* temporarily because there is no other place for it to go, brushing aside for the moment several obvious and good reasons for not doing so.

New Combinations

For those using Saccardo the following species are recombined:

Camarophyllus translucens = **Hygrophorus translucens**
Cortinellus subdecorosus = **Tricholoma subdecorosum**
Cortinellus totilividus = **Tricholoma totilividum**
Geopetalum suballiaceum = **Pleurotus suballiaceus**
Gymnopus alliaceus = **Collybia alliacea**
Lentodium floridanum = **Lentinus floridanus**
Lepista panaeoliformis = **Tricholoma panaeoliforme**
Limacella roseola = **Lepiota roseola**
Marasmiellus violae = **Marasmius violae**
Venenarius odoriferus = **Amanita odorifera**
Venenarius submutabilis = **Amanita submutabilis**

Fla. Agr. Exp. Station,
    Gainesville, Fla.

ADDITIONS TO THE UREDINALES OF VENEZUELA—II [1]

Frank D. Kern and H. W. Thurston, Jr.

There are two rather extensive lists of Venezuelan Uredinales. The first of these was published in 1930 by H. Sydow in Fungi venezuelani (Ann. Myc. **28**: 29–224, Uredinales, pp. 37–52). There are 65 species in that list. The second list was published by Kern, Thurston, and Whetzel in 1934 in Mycological Explorations of Puerto Rico (Monographs of the University of Puerto Rico, Series B., No. 2, Uredinales, pp. 262–303). That list recorded 184 species as the total number known to the authors at that time. Later it was discovered that one species had been reported under two names so that the total number should have been 183. Additions were made by Kern in 1938 (Mycologia **30**: 537–552) to the extent of 22 species.

We are now adding 33 species belonging to 11 genera, bringing the total up to 238. It should be understood that this total is based on the foregoing lists. These include the record of nine species by Patouillard and Gaillard in 1887 (Bull. Soc. Myc. France **4**: 7–46). We have not made an extensive search of the literature for incidental references to species. It cannot be claimed that these necessarily constitute first reports from Venezuela, although it seems likely that such may be the case with most of the species.

Several collectors have made possible the additions here presented. Their collections are deposited at Cornell University in the Department of Plant Pathology, being recent additions to a large collection known as "The Fungi of Venezuela." Duplicates

In the September–October number of Mycologia, 1938 (**30**: 537–552) there appeared a paper by the senior author entitled "Additions to the Uredinales of Venezuela." That paper was in reality No. I in this series although it was not so identified when published.

of many of the rust specimens in this collection are deposited at The Pennsylvania State College in the Department of Botany. The herbarium numbers cited in this paper are those from this consecutively numbered collection.   Doctor Carlos E. Chardon, now Director of the Institute of Tropical Agriculture, Mayaguez, Puerto Rico, resided in Venezuela from 1938 to 1941, and added to the collections which he had made on a previous exploration in 1937.   Mr. A. S. Müller was plant pathologist at the Federal Agricultural Experiment Station, El Valle, during the years 1937 to 1941, and made numerous collections.   Professor H. H. Whetzel, of Cornell University, made a collecting trip to Venezuela during the months of February, March, and April, 1939, and brought back many specimens.   Professor M. F. Barrus, also of Cornell University, was in Venezuela from October, 1939 to March, 1940 and spent some time collecting fungi.   Through influence exerted by these collectors some Venezuelan scientists became interested and have made their contributions.   Among these should be mentioned Sr. Francisco Tamayo and Sr. V. Badillo.

We are indebted to all of these men whose collecting has made possible these studies.   We are also indebted to numerous systematic botanists for aid in the determination of the hosts.   Without such assistance our work could not be carried on with despatch and accuracy.

Aecidium Byrsonimatis P. Henn. Hedwigia **34**: 101.   1895.
on *Brysonima crassifolia* H. B. K. road beyond Ortiz, entrance to
   Llanos, Est. Guarica, April 7, 1939, *H. H. Whetzel & A. S.
   Müller 3365;* savannas near Churruscao, west of San Fer-
   nando de Apure, Est. Apure, April 15, 1939, *C. E. Chardon
   3433.*

The pycnia and aecia of this species are produced by an unlimited mycelium which causes extensive hypertrophy of leaves and branches.   The white aecia are large and conspicuous.   Whetzel collected *Crossopsora notata* Arth. (specimen No. *3364*) at the same place with No. *3365* and has indicated his belief that this aecial stage may belong in an autoecious life cycle with *Crossopsora notata.*   This same suggestion was made by Arthur (Mem.

Torrey Club **17**: 114) in 1918. Jackson (Mycologia **23**: 361) has also proposed that *Crossopsora notata* might be an autoecious species with an aecial stage. However he did not have in mind *Aecidium Byrsonimatis* P. Henn., but a different type of aecidium which he described as *Aecidium vinulum* Jacks. & Holw. on *Byrsonima intermedia* from Brazil. We must conclude that the relationship of *Aecidium Byrsonimatis* is uncertain.

AECIDIUM GUATEMALENSE Kern & Kellerm. Jour. Myc. **13**: 23. 1907.

on *Heliotropium indicum* L. banks of Neveri, near Barcelona, Est. Anzoategus, May 26, 1938, *C. E. Chardon 2669.*

So far as we know, this is the second collection of the species. The type was collected in Guatemala by W. A. Kellerman in 1905. The correlated microcyclic species, *Puccinia Heliotropii* Kern & Kellerm., has been reported from Venezuela.

AECIDIUM XANTHOXYLINUM Speg. Rev. Argent. Hist. Nat. Buenos Aires **1**: 400. 1891.

on *Fagara* sp. aff. *rhoifolia* Engl. (*Xanthoxylon*), forest clearings, Central Lucinda, Est. Carabobo, April 13, 1938, *C. E. Chardon 2591.*

The type locality is in Paraguay. It has also· been reported from Brazil.

ANGIOPSORA COMPRESSA Mains, Mycologia **26**: 129. 1934.

on *Paspalum conjugatum* Berg. *Chardon, Toro & Alamo 189* (in previous list as *P. tubulosa*).

Paspalum decumbens Sw. *Kern & Toro 1710* (in previous list as *P. tubulosa*).

Paspalum Humboldtianum Flügge, *Chardon, Toro & Alamo 345* (in previous list as *P. tubulosa*) ; Galipan, Dist. Federal, April 23, 1934, *Kern & Toro 1693, 1698a.*

Paspalum paniculatum L. Rancho Grande, road. Maracay to Ocumare de la Costa, Est. Aragua, March 24, 1939, *H. H. Whetzel 3106.*

Paspalum plicatulum Michx. Monumento Carabobo, Est. Carabobo, Nov. 9, 1939, *Barrus & Müller 3627.*

This species was originally described as *Puccinia compressa* by Arthur & Holway (Arth. Proc. Am. Phil. Soc. **64**: 157.   1925) on *Paspalum elongatum* from Bolivia.   Only the uredo stage is present in our specimens.   We are indebted to Dr. G. B. Cummins for checking this determination.   Both Arthur and Mains have included illustrations in their papers.

MAINSIA LAGERHEIMII (P. Magn.) Jacks. & Holw. Mycologia **23**: 110.   1931.

on *Rubus robustus* Presl. San Antonio de los Altos, Est. Miranda, Nov. 5, 1939, *Barrus & Müller 3669; Rubus* sp. San Antonio de los Altos, Est. Miranda, May 14, 1938, *C. E. Chardon 2655;* forests near Papelon, above Caracas, Dist. Federal, July 8, 1938, *C. E. Chardon 2718;* Caracas a Colonia Tovar, Dist. Federal, March 17, 1939, *Whetzel & Müller 3006.*

Originally described from Ecuador by Lagerheim on *Rubus* sp. as *Uromyces andinus* (Bull. Soc. Myc. Fr. **11**: 213.   1895) and renamed *U. Lagerheimii* by Magnus (Ber. Deutsch. Bot. Ges. **14**: 377.   1896) because the specific name *andinus* was not tenable. Mayor reported it from Colombia on *Rubus glaucus*.   It has also been called *Spirechina Lagerheimii* by Kern & Whetzel (Jour. Dept. Agr. Puerto Rico **14**: 309.   1930).

MILESIA AUSTRALIS Arth. Bull. Torrey Club **5**: 53.   1924.

on *Blechnum fraxineum* Willd. road Caracas to Ocumare del Tuy, March 11, 1939, Est. Miranda, *Whetzel & Müller 2980;* road Maracay to Choroni, Est. Aragua, April 9, 1939, *Chardon, Whetzel & Müller 3376.*

   Blechnum occidentale L. road near Los Teques, Est. Miranda, March 9, 1939, *Whetzel & Müller 2935.*

This species is known from Puerto Rico and from Chili, Colombia, and Ecuador in South America.   Faull has designated the rust on *B. occidentale* as forma *irregularis*.   The uredospores have irregularly scattered spines and minute warts as against evenly spinulose spores on the type host, *B. auriculatum*, from Chili which he calls forma *typica*.   (See Faull, Cont. Arnold Arboretum II, pp. 41–46.   1932).   Our specimens on the new host *B. fraxineum* appear to be forma *irregularis*.

PHAKOPSORA VIGNAE (Bres.) Arth. Bull. Torrey Club **44**: 509. 1917.

on *Phaseolus lunatus* L. Caracas, Dist. Federal, Jan. 15, 1939, *A. S. Müller 2353.*

Known also from the West Indies, Japan, Java and the Philippine Islands.

PROSPODIUM TUBERCULATUM (Speg.) Arth. N. Am. Flora **7**: 161. 1912.

on *Lantana achyranthifolia* Desf. Tucupe, road beyond El Valle, Caracas, Dist. Federal, March 1, 1939, *Whetzel & Müller 2864.*

Known from the West Indies, Central America, and several South American countries. Cummins in his Monograph on the genus *Prospodium* (Lloydia **3**: 15. 1940) lists several species of *Lantana* but not *L. achyranthifolia.* No other species of *Prospodium* is known to occur on *Lantana.*

PUCCINIA ANCIZARI Mayor, Mem. Soc. Neuch. Sci. Nat. **5**: 525. 1913.

on *Baccharis cassinefolia* DC. Caracas a Colonia Tovar, Dist. Federal, March 19, 1939, *Whetzel, Müller & Tamayo 3072.*

This is an extension of the range from Colombia to Venezuela. Arthur (N. Am. Flora **7**: 476. 1921) uses the name *P. Ancizari* for a Guatemalan rust. Obviously the Guatemalan specimen is not this species; Jackson has supplied the name *P. interjecta* (Mycologia **24**: 148. 1932) for it.

PUCCINIA ARTHURELLA Trotter in Sacc. Syll. Fung. **23**: 694. 1925.

   Puccinia proximella Arth., 1925; not *P. proximella* P. & H. Sydow 1912.

on *Lactuca intybacea* Jacq. Antimano, Dist. Federal, Jan. 7, 1940, *Francisco Tamayo 3769.*

This is a uredo stage only. The spores are $18–20 \times 21–24\,\mu$ which is a close agreement with the size given for *Puccinia Arthurella. Puccinia minussensis* Thüm. has slightly larger uredospores,

17–25 × 23–27 μ.   The cinnamon-brown color of the sori of our specimen also agrees with *Puccinia Arthurella*.   This appears to be the first report of the species outside the West Indies.

PUCCINIA BOMAREAE (Lagerh.) P. Henn. Hedwigia **35**: 342. 1896.

on *Bomarea multiflora* (L.f.) Mirb. forests at Los Venados, above Caracas, Dist. Federal, July 8, 1938, *C. E. Chardon 2695*.

This species was originally described from Ecuador; it is known also from Colombia, Bolivia and Brazil.

PUCCINIA CHAETOCHLOAE Arth. Bull. Torrey Club **34**: 585.   1907.

on *Setaria geniculata* (L.) Scrib. gardens at Las Delicias, near Maracay, Est. Aragua, June 16, 1932, *Chardon, Toro & Alamo 163* (in previous list as *P. substriata*).

This specimen has been studied by Dr. G. B. Cummins and identified as *P. Chaetochloae* in his recent paper on tropical grass rusts (Mycologia **34**: 678.   1942).

PUCCINIA DOLOSA Arth. & Fromme, Torreya **15**: 262.   1915.

on *Paspalum paniculatum* L. vicinity of Merida, *C. E. Chardon 1120* (in original list as *P. tubulosa*) Rio Chico, Est. Miranda, Nov. 2, 1937, *A. S. Müller 2028;* Caracas, Dist. Federal, Dec. 16, 1937, *A. S. Müller 2084;* Tabay, Est. Merida, Nov. 11, 1939, *Barrus & Müller 3629*.

We are indebted to Dr. G. B. Cummins for examining these specimens and for his opinion about *Puccinia dolosa*.   This species was established in 1915 by Arthur & Fromme.   Later in the N. Am. Flora **7**: 287, 1920, they made it and *Puccinia Puttemansii* P. Henn. synonyms of *Puccinia Huberi* P. Henn.   Still later in Proc. Am. Phil. Soc. **54**: 176, 1925, Arthur reached the conclusion that *Puccinia Huberi* and *P. Puttemansii* P. Henn. were to be regarded as synonyms of *Puccinia levis* Magnus.   At the same time he listed *P. dolosa* as a synonym of *Puccinia substriata* Ellis & Barth.   Dr. Cummins believes that *Puccinia dolosa* is a distinct and valid species.   (See Mycologia **34**: 681–682.   1942.)   The uredospores are small and have thin brownish walls and echinulate

markings. They are triangular in end view with three pores in the angles. The telia are inconspicuous, covered, and the teliospores are irregular, brittle and apt to be broken in a mount. They are easily overlooked. *P. Huberi* and *P. Puttemansii* have early naked, pulvinate telia. Our specimen No. *2028* has both uredinia and telia; No. *3629* has only uredinia.

PUCCINIA KAERNBACHII (P. Henn.) Arth. Bull. Torrey Club **46**: 110. 1919.
on *Andropogon* sp. Caracas, Dist. Federal, Dec. 28, 1938, *A. S. Müller 2324.*

We have reported two species, *Puccinia meridensis* and *Uredo rubida* from Venezuela on *Andropogon*. *P. Kaernbachii* with its dark colored uredospores and paraphyses is quite different. It has been widely reported from the warmer regions of the world.

PUCCINIA LEPTOCHLOAE Arth. & Fromme, Torreya **15**: 263. 1915.
on *Leptochloa virgata* (L.) Beauv. El Valle, Caracas, Dist. Federal, Dec. 17, 1939, *Barrus & Müller 3739.*

The uredinia are badly parasitized in this specimen; the uredospores are slightly smaller and somewhat thinner-walled than the measurements in the original description. The telia are abundant and fairly typical. This species was described from Paraguay by Dr. Spegazzini under the name *Puccinia subtilipes* (An. Mus. Nac. Hist. Nat. Buenos Aires **31**: 386. 1922) which is to be regarded as a synonym. In North America it occurs in the southern United States, Mexico and the West Indies.

PUCCINIA LYGODII (Har.) Arth. Bull. Torrey Club **51**: 55. 1924.
on *Lygodium venustum* Sw. road Maracay to Guigue, Est. Aragua, April 1, 1939, *Chardon, Whetzel & Müller 3271.*

The type of this species was collected at Pernambuco, Brazil. Faull has a full account of the species under "Excluded species" in his Monograph of the genus *Milesia* (Cont. Arnold·Arboretum II, pp. 121–122. 1932). He knew of six collections—three from Brazil, one each from Trinidad, El Salvador, and British Guiana. Arthur proposed the combination *Puccinia Lygodii* on the strength of stalked septate teliospores which he reports finding on a Bra-

zilian specimen collected by Rose & Russell (No. *21514*). We have had the opportunity of examining these teliospores through the kindness of Dr. G. B. Cummins, and see no reason for not accepting Dr. Arthur's reference of the species to the genus *Puccinia*. Sydow described a new species, *Milesina Lygodii* on *Lygodium* sp. from British Guiana (Mycologia **17**: 255. 1925). He did not find any teliospores and there is no reason for believing it belongs to the genus *Milesia;* the uredo is in all respects like all the other specimens known on *Lygodium*.

PUCCINIA MACRA Arth. & Holw.; Arth. Am. Jour. Bot. **5**: 465.
      1918.
on *Paspalum candidum* (Humb. & Bonpl.) Kunth. LaVenta, Est.
      Merida, Nov. 11, 1939, *Barrus & Müller 3625*.

This species was described from Guatemala. It has since been reported from Costa Rica, Bolivia, Colombia. Arthur recorded it also from Ecuador, but according to Cummins, that was an error (see Mycologia **34**: 687–688. 1942). Our specimen (*Barrus & Müller 3625*) has been reported from Venezuela by Cummins (l.c.) ; the species, *Puccinia macra,* is nevertheless an addition to the Venezuelan lists of Uredinales cited in the first paragraph of this paper.

PUCCINIA RUELLIAE (Berk. & Br.) Lagerh. Tromsö Mus. Aarsh.
      17: 71. 1895.
on *Blechum Brownei* (Sw.) Juss. Guarenas, Est. Miranda, March
      18, 1938, *A. S. Müller 2130;* road Maracay to Guigue, Est.
      Aragua, April 5, 1939, *Chardon, Whetzel & Müller 3324;*
      Barcelona, Est. Anzoategui, Feb. 1, 1940, *M. F. Barrus 3805*.
   Ruellia tuberosa L. road near San Mateo, Est. Aragua, March
      9, 1939, *Whetzel & Müller 2938;* road Maracay to Guigue,
      Est. Aragua, March 31, 1939, *Chardon, Whetzel & Müller
      3253*.

Arthur in the N. Am. Flora (vol. **7**, p. 415, 1921) includes the rust on *Blechum* under *P. Ruelliae*. In reporting the rusts of Colombia we followed Arthur. Jackson in his studies of South American rusts (Mycologia **24**: 95. 1932) prefers to use the name *Puccinia Blechi* Lagerh. for the rust on *Blechum*.

PUCCINIA SUBCORONATA P. Henn. Hedwigia **34**: 94.   1895.
on *Cyperus* aff. *alternifolius* L. Dominguez farm, Chacao, Dist.
    Federal, April 28, 1934, *Kern & Toro 1719.*

This rust is known also from Colombia, Trinidad, British Guiana,
Costa Rica, Honduras and Panama.

RAVENELIA PITHECOLOBII Arth. Bot. Gaz. **39**: 394.   1905.
on *Pithecolobium dulce* (Roxb.) Benth. Guatire, Est. Miranda,
    March 18, 1938, *A. S. Müller 2132.*

Known also from Florida, Cuba, Puerto Rico and Mexico.

SCOPELLA SAPOTAE (Arth. & Johnston) Mains, Ann. Myc. **37**: 59.
    1939.   .
    Uredo Sapotae Arth. & Johnston, Mem. Torrey Club **17**: 169.
    1918.
on *Achras Sapota* L. (*Sapota Achras* Mill.), Caracas, Dist. Fed-
    eral, Dec. 28, 1938, *A. S. Müller 2337;* Los Chorros, Caracas,
    Dist. Federal, Feb. 22, 1939, *Whetzel & Müller 2812.*

This appears to be the second report outside the islands Ber-
muda, Cuba, Bahamas, and Santo Domingo.   Mains has reported
it from British Honduras, Central America.   For information
about the genus *Scopella* see Mains, Ann. Myc. **37**: 59.   1939.

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UREDO BORRERIAE (P. Henn.) Kern & Whet. Mycologia **18**: 42.
    1926.
on *Borreria verticillata* (L.) G. F. W. Mey. Petare, Est. Miranda,
    May 14, 1937, *A. S. Mülleri 1848.*

The type locality is in Brazil.   It is reported also from Puerto
Rico.

UREDO INGAE P. Henn. Hedwigia Beibl. **38**: 69.   1899.
on *Inga fastuosa* Willd. La Cortada, San Antonio de los Altos, Est.
    Miranda, April 3, 1938, *Chardon & Tate 2613.*   .

This uredinial stage has spores with echinulate markings.   The
best name for it seems to be *Uredo Ingae.*   For further notes on
Inga rusts see Mycologia **32**: 622–623, 1940.

Uredo Lycoseridis sp. nov.

Uredosoris epiphyllis, in gregibus 2–4 mm. diam., in maculis flavis insidentibus, minutis, rotundatis vel ovatis, 0.3–0.6 mm. diam., tarde nudis, obscure castaneo-brunneis, epidermide rupta visibile; uredosporis late ellipsoideis vel obovoideis, 26–31 × 34–42 μ; tunica obscure cinnamomeo-brunnea, 1.5–2 μ cr., crassissimis sparse echinulata, spinis ad 3 μ longis; poris 2, aequatorialibus.

on *Lycoseris oblongifolia* Rusby, Las Trincheras, Est. Carabobo, Feb. 24, 1940, *Barrus & Müller 3857* (type); Hacienda Lucinda, Urama, Est. Carabobo, April 3, 1939, *Chardon, Whetzel & Müller 3297.*

We do not find that any rust has been described on this host and no similar rust is known on a closely related host. The species is characterized by the large spores which are unusually coarsely echinulate. In sections there is evident a growth of stromatic tissue about the sori, but we fail to make out any definite peridial development.

Uromyces Asclepiadis (Schw.) Cooke, Grevillea **5**: 152.   1877.
on *Asclepias curassavica* L., banks of Neveri, near Barcelona, Est. Anzoategui, May 26, 1938, *C. E. Chardon 2680.*

A common rust in North America; in South America known from Colombia, Brazil, and Peru.

Uromyces caryophyllinus (Schr.) Wint. in Rab. Krypt.-Fl. 1^1: 149.   1881.
on *Dianthus caryophyllus* L. Merida, Est. Merida, April 8, 1939, *J. Camero-Tamara 3074.*

This rust is world-wide in its distribution, apparently occurring in every state and country where carnations are grown. Arthur, in his Manual of the Rusts of U. S. and Canada, records it from South America. We do not know from what countries there it has been reported.

Uromyces Cestri (Mont.) Lév. Ann. Sci. Nat. III. **8**: 371.   1847.
on *Cestrum latifolium* Lam. Rancho Grande, road Maracay to Ocumare de la Costa, Est. Aragua, March 29, 1939, *Whetzel & Müller 3204.*

This species is widely distributed in South America, Central America, and the West Indies.

Uromyces flectens Lagerh. Sv. Bot. Tidskr. 3: 36. 1909.
on *Trifolium repens* L. Paramo Zumbador, Est. Tachira, Nov. 14,
1939, *Barrus & Müller 3590;* Bailadores, Est. Merida, Nov.
13, 1939, *Barrus & Müller 3595.*

Only teliospores are present. Jackson has included specimens
from Chile, Bolivia, and Ecuador under this species (Mycologia
23: 353. 1931). It is known also from Europe and Asia.

Uromyces Indigoferae Diet. & Holw.; Holway, Bot. Gaz. **31**:
328. 1901.
on *Indigofera mucronata* Spreng. Caracas, Dist. Federal, Aug. 29,
1938, *A. S. Müller 2257.*

We have found no report of this species from South America;
it is known from Texas, Mexico, and Central America.

Uromyces megalospermus Speg. Anal. Mus. Buenos Aires 218.
1899.
on *Tessaria integrifolia* Ruiz. & Pav. Chirgua, Est. Carabobo, Dec.
15, 1939, *M. F. Barrus 3737.*

Originally described from Argentina; known also from Colom-
bia and Peru.

Uromyces Neurocarpi Diet. Hedwigia **34**: 292.. 1895.
on *Clitoria rubiginosa* Juss. (*Martiusia rubiginosa* Britton), Se-
bastopol, Los Teques, Est. Miranda, Sept. 11, 1938, *V. Ba-
dillo 2302.*
Clitoria guianensis (Aubl.) Benth. Soledad, Est. Anzoategui,
Sept. 30, 1939, *A. S. Müller 3485.*

Type locality Brazil; known also from Puerto Rico, Jamaica,
Cuba, Trinidad, El Salvador, Ecuador, and Colombia.

Uromyces Scleriae P. Henn. Hedwigia Beibl. **38**: 67. 1899.
on *Scleria macrophylla* Presl. road to Chirgua, Est. Carabobo,
March 8, 1939, *Whetzel & Müller 2953.*

Originally from Brazil; in South America known also from Brit-
ish Guiana and Trinidad; in North America from Cuba, Puerto
Rico, and Santo Domingo.

Uromyces Tripsaci sp. nov.

·Uredosoris et uredosporis incognitis.

Teleutosoris epiphyllis, gregariis, in maculis decoloratis insidentibus, inter-costalibus, oblongis vel linearibus, epidermide diu tectis, tandem rimose de-hiscentibus, castaneo-brunneis; teliosporis oblongis vel anguste ellipsoideis, 19–26 × 42–66 μ; tunica aurato- vel pallide cinnamomeo-brunnea, supra pal-lidiore, 1.5–2 μ cr., apice ad 7–10 μ incrassata, levi; poro unico prope basim praeditis; pedicello brevissimo, deciduo.

on *Tripsacum dactyloides* L. Valera, Est. Trujillo, Nov. 11, 1939, *Barrus & Müller 3624.*

This is an unusual rust in several respects. The telia are long covered by the epidermis but finally become exposed by longi-tudinal slits. The teliospores are pedicellate but the pedicels break away close to the spore. Even in sections the spores appear de-tached. There is a single pore which is located near the hilum. No uredo stage is present; we have not even found stray uredo-spores among the teliospores. Not only is there nothing on *Trip-sacum* like it—we do not know any grass rust which is similar.

DEPARTMENT OF BOTANY,
    THE PENNSYLVANIA STATE COLLEGE

UREDINALES FROM THE NORTHWEST HIMALAYA [1]

GEORGE B. CUMMINS

(WITH 7 FIGURES)

The rusts reported in this paper were collected by Dr. R. R. Stewart or by R. R. and I. D. Stewart in the northern part of the United Provinces and in the Punjab, Kashmir and the Northwest Frontier Province of India. For an account of an early collection by Stewart from this region see Arthur and Cummins (Mycologia **25**: 397–406. 1933). Species marked with an asterisk represent new records for India.

Specimens, including types, are in the Arthur Herbarium, Purdue University Agricultural Experiment Station, the Gordon College Herbarium, Rawalpindi, India and the Herbarium of the New York Botanical Garden. The collection was made available for study through the courtesy of Dr. R. R. Stewart and Dr. Fred J. Seaver.

AECIDIUM CALLIANTHÙM Sydow, *Desmodium tiliaefolium* G. Don, Uri-Aliabad, Jhelum Valley, July 1934, *13952.*

AECIDIUM CRYPTICUM Kalchbr. & Cooke, *Gerbera lanuginosa* Benth., Landour, Aug. 8, 1934, *14215,* Aug. 11, 14, 1937, *15976, 16037,* Aug. 5, 1938, *16656A, 16695.*

AECIDIUM FLAVESCENS Barclay, *Senecio rufinervis* DC., Landour, Aug. 12, 1937, *15996.*

AECIDIUM GIRARDINIAE Sydow, *Girardinia heterophylla* Dcne., Landour, July 22, 31, 1937, *15899, 15958.*

AECIDIUM HEDERAE Wakef., *Hedera Helix* L., Murree, June, July 1935, *14745A.*

This species was published by Arthur and Cummins (Mycologia **25**: 398. 1933) as a new species, *Aecidium Hederae,* but this was antedated by Miss Wakefield's publication (Bull. Misc. Inform. Kew **1931**: 202. 1931). Miss Wakefield kindly sent me a por-

tion of the type specimen for comparison and the rusts are clearly identical.

AECIDIUM MONTANUM Butler, *Berberis ceratophylla* G. Don, Murree, June 29–30, 1934, *13893,* June 1935, *15354; Berberis petiolaris* Wall., Murree, June 1935, *14740A, 14752A,* May 28, 1937, *15889A; Berberis Zabeliana* C. K. Schum., Rattu, Gilgit Road, Aug. 21, 1939, *18839,* above Chorwan, Gilgit Road, July 25, 1940, *19732.*

*Aecidium plectranthicola sp. nov.

Pycniis epiphyllis in maculis flavidis vel brunneis usque ad 6 mm. diam., subepidermalibus, globoideis, 75–100 μ diam., paraphysatis. Aeciis hypophyllis, aggregatis, cupulatis, 150–200 μ diam.; cellulis peridii ellipsoideis vel oblongis, 18–23 × 27–33 μ, pariete interiore moderate verrucoso 2.5–3 μ cr., exteriore striato 3–5 μ cr.; aeciosporae globoideae, ellipsoideae vel oblongo-ellipsoideae, 15–23 × 23–29 μ; membrana hyalina, 1–1.5 μ cr., ad apicem usque ad 8 μ cr., verrucosa.

On *Plectranthus coetsa* Buch.-Ham., Landour, July 22, 1937, *15905,* July 24, 1937, *R. R. Stewart 15919* (type).

A. plectranthicola is clearly distinct from *A. Plectranthi* Barclay, which occurs on the same host, because of the strongly thickened apical walls of the aeciospores.

AECIDIUM RANUNCULACEARUM DC., *Ranunculus hirtellus* Royle, Deosai Plains toward Skardu, July 28, 1940, *19966.*

*AECIDIUM SAUSSUREAE Johans.?, *Saussurea Candolleana* Wall., above Chorwan, July 25, 1940, *19684.*

AECIDIUM SCUTELLARIAE Sydow, *Scutellaria angulosa* Benth., Landour, July 27, 31, 1937, *15936, 15944, 15954.*

*Aecidium Stewartianum sp. nov.

Pycniis epiphyllis, in maculis brunneis usque ad 5 mm. diam., subepidermalibus, paraphysatis. Aeciis hypophyllis, aggregatis, cupulatis, 0.2–0.3 mm. diam., flavidis; cellulis peridii oblongis, ellipsoideis vel polyhedricis, 16–25 × 24–32 μ, flavidis, pariete exteriore moderate verrucoso 2–2.5 μ cr., interiore striato 3–4 μ cr.; aeciosporae globoideae, ellipsoideae vel oblongo-ellipsoideae, 15–19 × 19–26 μ; membrana hyalina, minuteque verrucosa, 1–2 μ cr., ad apicem usque ad 13 μ cr.

On *Heracleum candicans* Wall., near Taubat, Kishenganga Valley, Kashmir, July 25–26, 1939, *R.R. & I.D. Stewart 17913* (type).

The apically thickened walls of the aeciospores distinguish *A. Stewartianum* from other aecial forms on *Heracleum.*

AECIDIUM TANDONII Mitter, *Deutzia staminea* R. Br., Camel's Back Road, Mussoorie, Aug. 18, 1934, *14351,* Sept. 29, 1937, *16055;* Landour, Aug. 30, 1934, *14493,* Sept. 4, 1936, *15718;* to Benog from Mussoorie, Aug. 30, 1937, *16095A.*

COLEOSPORIUM INULAE (Kunze) Rabenh., *Inula nervosa* Wall., Landour near Mussoorie, Aug. 15, 1936, *15556A.*

COLEOSPORIUM LEPTODERMIDIS (Barclay) Sydow, *Leptodermis lanceolata* Wall., Landour, Aug. 25, 1936, *15613A,* Aug. 19, 1937, *16053.*

COLEOSPORIUM PLECTRANTHI Barclay, *Plectranthus strictus* Benth., Landour, Aug. 25, 1934, *14458; Plectranthus* sp., Mussoorie, Aug. 11, 1937, *15968.*

*ENDOPHYLLUM TUBERCULATUM (Ellis & Kellerm.) Arth. & Fromme, *Lavatera kashmiriana* Camb., below Minimarg, Kishenganga Valley, August 1939, *19230A.*

This species has not been reported previously as occurring outside of the plains area of the western United States where it parasitizes *Althaea, Callirhoë* and *Sidalcea.* Stewart's specimen agrees in all respects with the American material and there appears to be no reason to doubt its identity.

*GYMNOSPORANGIUM CLAVARIAEFORME (Jacq.) DC., *Cotoneaster integerrima* Medik., above Rattu, Gilgit Road, Aug. 21, 1939, *18846,* Godai to Chillam, Gilgit Road, Aug. 25, 1939, *18964; Cotoneaster nummularia* F. & M., Chorwan, Aug. 16, 1939, *18607,* July 24, 1940, *19667;* Rattu above Astor Valley, Aug. 19–20, 21, 1939, *18781, 18825;* Rupal Nullah, Nanga Parbat, Aug. 22, 1939, *18887.*

Both leaves and fruits are infected in these collections. The aeciospores and peridial cells agree with those of *G. clavariaeforme.* Tranzschel (Conspectus Uredinalium URSS, p. 216. 1939) records only *G. fusisporum* Ed. Fischer on these two hosts but the peridial cells in the Indian collections are verrucose as in *G. clavariaeforme* and not ridged as described and figured by Fischer (Mitt. Nat. Ges. Bern **1917**: 73. 1918) for *G. fusisporum.*

Stewart notes that the host of No. 19667 was "growing under *Juniperus macropoda*" and the collection of galls (No. 19666) from the juniper bears the notation "Adjacent plants of *Cotoneaster* were rusted." The galls bear old telial scars which appear

not to have been caused by *G. clavariaeforme*. For further comments see *G. confusum*.

*GYMNOSPORANGIUM CONFUSUM Plowr., *Crataegus oxyacantha* L., Rupal Nullah, Aug. 22, 1939, *18880;* Badwan, Kishenganga Valley, July 21, 1940, *19596; Pyrus lanata* Don, Chorwan, Aug. 10, 1939, *18600; Juniperus macropoda* Boiss., Chorwan, July 24, 1940, *19666.*

While the aecial collections appear unquestionably to be *G. confusum* the telial collection is less certain. The galls are fusiform and bear old telial scars which appear like those of *G. confusum*. A few old teliospores were found which agreed fairly well with the thinner-walled type of *G. confusum* and were too small and regular in shape to suggest *G. fusisporum*. A notation on the packet is as follows: "Adjacent plants of *Cotoneaster* were rusted." The concerned aecial collection (No. 19667) is listed under *G. clavariaeforme*. Such close association is highly suggestive but not conclusive since aecia of *G. confusum* were also collected (No. 18600) at Chorwan the previous year. In any case the telial scars do not suggest *G. clavariaeforme*. Identity of these Indian *Gymnosporangia* can be decided definitely only when cultures have been made to determine the alternate hosts.

GYMNOSPORANGIUM CUNNINGHAMIANUM Barclay, *Cotoneaster bacillaris* Wall., Landour, Aug. 16, 1934, Aug. 15, 1936, *14388, 15565; Pyrus pashia* Buch.-Ham., Landour, July 27, 1935, *14854A,* July 1936, *15541, 15552,* July 24, 31, 1937, *15921, 15950.*

GYMNOSPORANGIUM DISTORTUM Arth. & Cumm., *Cotoneaster bacillaris* Wall., Rajdhiangan Pass, Gilgit Road, July 19, 1940, *19528.*

This species was originally described (*l.c.,* p. 400) from fragmentary material but the present collection is abundant and in fine condition. The aecia are horn-shaped, 0.5–1 mm. in diameter at the base and 3–4 mm. in length, and occur on somewhat hypertrophied and distorted twigs (FIG. 1). For illustrations of the aeciospores and peridial cells see the original publication.

According to Crowell (Can. Jour. Res. C., **18**: 479. 1940) *G. distortum* also occurs in western China.

MELAMPSORA AECIDIOIDES (DC.) Schroet., *Populus alba* L., Abbottabad, Hazara, April 1935, *14635.*

*MELAMPSORA LARICI-EPITEA Kleb., *Salix hastata* L., below Kun Patthar, Aug. 14, 1939, *18528;* Burzil Chowki, Gilgit Road, July 26, 1940, *19771; Salix oxycarpa* Anders.?, Godai above Gurikot, Aug. 24, 1939, *18942.*

M. Larici-capracarum Kleb. is the only *Salix* rust listed by Butler and Bisby (Fungi of India, p. 60. 1931) and they point out that there are probably two or more species of *Melampsora* involved and that perhaps none of them is *M. Larici-capracarum.* Stewart's collections quite certainly are not that species since the teliospores (present in No. 18942) are not thickened apically.

Insofar as the morphology of the paraphyses, urediospores and teliospores is concerned the Stewart specimens show complete agreement with *M. Larici-epitea.* I was not able, however, definitely to determine the position of the telia with respect to the epidermis but believe them to be either subcuticular or intra-epidermal in origin.

MONOSPORIDIUM ANDRACHNIS Barclay, *Andrachne cordifolia* Muell., Jabberkhet near Landour, Aug. 1, 1934, *14181,* Landour, August 1935, *14868A,* July 22, Aug. 14, 1936, *15541A, 15555.*

PHRAGMIDIUM BUTLERI Sydow, *Rosa macrophylla* Lindl., near Waziri Thal, Tilel Dist., Aug. 14, 1939, *18514A.*

PHRAGMIDIUM POTENTILLAE (Pers.) Karst., *Potentilla argentea* L., Gurikot, Astor Valley, Aug. 23, 1939, *18917.*

PHRAGMIDIUM ROSAE-MOSCHATAE Dietel, *Rosa moschata* J. Hermm., Murree, June 1935, *14751A; Rosa Webbiana* Wall., Satpura Nullah above Skardu, Aug. 3, 1940, *20349;* beyond Dras, Ladak Road, Aug. 28, 1940, *21124.*

*PUCCINIA ACROPHILA Peck, *Lagotis glauca* Gaertn., Deosai Plains on Skardu Road, July 30, 1940, *20071.*

P. acrophila occurs on *Besseya* and *Synthris* in the Rocky Mountains from Colorado to Montana and has been considered to be strictly an American species. Moreover, the usual rust on *Lagotis* is *Puccinia Gymnandrae* Tranz., a species of Asiatic distribution but recently found also in Alaska. The two species are generally similar but *P. acrophila* has shorter and broader teliospores than does *P. Gymnandrae.* Stewart's specimen agrees in all respects with *P. acrophila.*

PUCCINIA AINSLIAEAE Sydow, *Ainsliaea pteropoda* DC., Landour, Sept. 3, 1936, *15652,* July 31, 1937, *15952;* Cloud End, Aug. 30, 1937, *16097.*

*PUCCINIA BEHENIS (DC.) Otth, *Lychnis inflata* Wall., Shankargarh, Upper Astor Valley, Aug. 18, 1939, *18754; Silene latifolia*
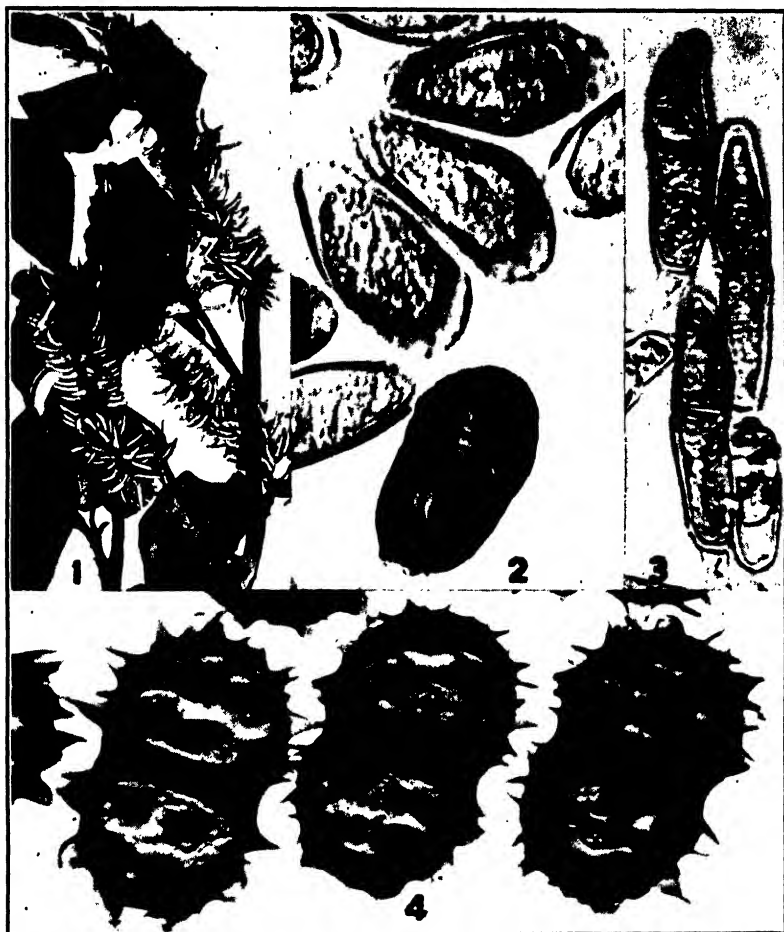
FIG. 1, aecia of *Gymnosporangium distortum* Arth. & Cumm. on *Cotoneaster bacillaris* (from Stewart *19528*) × 1; 2, urediospores and one teliospore of *Puccinia heracleicola* Cumm. on *Heracleum Thomsoni* var. *glabrior* (from type) × 800; 3, teliospores of *Puccinia Holboelliae-latifoliae* Cumm. on *Holboellia latifolia* (from type) × 800; 4, teliospores of *Puccinia Prostii* Moug. on *Tulipa stellata* (from Stewart *13677*) × 800.

(Mill.) Britt. & Rendle (*S. inflata* Sm.), Upper Astor Valley, Aug. 19–20, 1939, *18743A*.

*Puccinia Ribesii-caricis Kleb., *Ribes nigrum* L., Chillam, Gilgit Road, Aug. 25, 1939, *18953*.

Puccinia Circaeae Pers., *Circaea alpina* L., Jabberkhet, Aug. 24, 1935, *14970;* Badwan below Gurez, Aug. 30, 1939, *19236A, 19238*.

Puccinia coronata Corda, *Berchemia lineata* DC., above Uri, Sind Valley, July 1934, *13921;* *Rhamnus pentapomica* Parker, Bataki, lower Kishenganga Valley, July 8, 1939, *17336;* *Rhamnus virgata* Roxb., Changla Gali, Murree Hills, July 1934, *14009;* Landour, Aug. 8, 1934, *14265*.

*Puccinia Drabae Rud., *Draba altaica* Bunge, Zojibal Pass, Aug. 10, 1939, *18024*.

Puccinia extensicola Plowr., *Solidago virga-aurea* L., Keran, July 7, 1939, *17566*.

Puccinia Gentianae (Str.) Link, *Gentiana thianshanica* Rupr., Chillam beyond Burzil, Aug. 25, 1939, *18974;* Chillam, Gilgit Road, Aug. 26, 1939, *18969*.

Puccinia graminis Pers., *Berberis asiatica* Roxb., Landour, Aug. 9, 1934, *14271,* summer, 1936, *15617A,* Aug. 20, 1937, *16052;* *Berberis ceratophylla* Don, Jhelum Valley, July 1934, *14008;* Dhanni-Titwal, July 9, 1939, *17403*.

✓Puccinia Heraclei Grev., *Heracleum candicans* Wall., Minimarg, Aug. 29, 1939, *19176*.

*Puccinia heracleicola sp. nov (FIG. 2.)

Uredia caulicola et inflorescenticola, distortiones efficientia, in lineas usque ad 1.5 cm. confluentibus, epidermide rupta conspicue, cinnamomeo-brunnea, pulverulenta; urediosporae ovoideae, oblongo-ellipsoideae vel oblongae, 18–25 $\times$ 32–46 (–49)μ; membrana plus minusve bilaminata, 2–3 μ cr., ad basim 3–5 μ cr., ad apicem 5–8 μ cr., aureo- vel pallide cinnamomeo-brunnea, pariete exteriore subhyalino, moderate echinulata; poris germ. 3, aequatorialibus. Telia caulicola, rotundata vel oblonga, 0.3–1.5 mm. longa, pulverulenta, castaneo-brunnea; teliosporae ellipsoideae utrinque rotundatae, medio leniter constrictae, 21–25 $\times$ 30–40 μ; membrana castaneo-brunnea, moderate verrucosa, 2.5–3 μ cr. vel ad apicem 3–4 μ cr.; poro superiore apicali, inferiore juxta septum sito; pedicello hyalino, sporam aequante sed fragili et deciduo.

On *Heracleum Thomsoni* var. *glabrior* C. B. Clarke, ascent Lohan Gali, near Tilel, Kashmir, Aug. 14, 1939, *R. R. & I. D. Stewart 18495* (type).

This species, characterized by the large, apically thickened urediospores, has the appearance of a brachy-form but pycnia were not found in sections. The uredia occur most commonly at the base of the umbels, where the infection causes distortion of varying severity, or less commonly singly on the stems. Frequently, the flowers and fruits are also infected.

The pores of the teliospores occur in slightly thickened areas of the wall but are not covered by a differentiated papilla or umbo. Mesospores are rare.

Puccinia heterospora Berk. & Curt., *Sida veronicaefolia* Lam., Jabberkhet, Aug. 25, 1937, *16073;* Kalanga Hill, Rajpur, Sept. 7, 1937, *16141.*

Puccinia Hieracii (Schum.) Mart., *Hieraceum vulgatum* Koch, Chorwan to Burzil Chowki, July 26, 1940, *19808;* Zoji Pass, Ladak Road, Aug. 30, 1940, *21246.*

*Puccinia Holboelliae-latifoliae sp. nov. (fig. 3.)

Teliis hypophyllis, in maculis brunneis 1–2 mm. diam. laxe aggregatis, rotundatis, 0.1–0.2 mm. diam., pulvinatis, brunneis; teliosporae cylindraceae, ad apicem rotundatae vel leniter attenuatae, ad basim leniter attenuatae, medio vix constrictae, 9–15 × 38–57 μ; membrana 1–1.5 μ cr. vel ad apicem 1.5–3 μ cr., aurea vel pallide cinnamomea, levi; pedicello persistenti, hyalino, sporam aequante.

On *Holboellia latifolia* Wall., Camel's Back, Mussoorie, Sept. 24, 1937, *R. R. Stewart 16058* (type).

This microcyclic species is characterized by the formation of relatively few, small telia in dark brown spots and by its long, narrow spores. No previously described rust on Berberidaceae is similar.

Puccinia Iridis (DC.) Wallr., *Iris kashmiriana* Baker, Kashmir Valley, July 1934, *14051.*

Puccinia Leveillei Mont., *Geranium collinum* Steph., Satpura Nullah, Baltistan, Aug. 2, 1940, *20230; Geranium pratense* L., ascent Lohan Gali, Aug. 14, 1939, *18485, 18485A; Geranium rectum* Trautv., Kun Patthar, Aug. 14, 1939, *18255A; Geranium* sp., Kun Patthar to Waziri Thal, Aug. 14, 1939, *18515A.*

*Puccinia Libani P. Magn., *Prangos pabularia* Lindl., Lohan Gali near Purana Tilel, Aug. 14, 1939, *18498.*

*PUCCINIA LIGUSTICI Ellis & Ev., *Selinum papyraceum* C. B. Clarke, Burzil Chowki, Gilgit Road, July 27, 1940.

This microcylic species occurs in North America on species of *Angelica, Carum, Coyswellia, Coneoselinum, Ligusticum, Oxypolis* and *Sanicula.* Stewart's collection agrees in all respects with American material.

*PUCCINIA LONGIROSTRIS Kom. (FIG. 7), *Lonicera asperifolia* H. & T., Satpura Valley above Skardu, Baltistan, Aug. 3, 1940, *20310.*

FIG. 5, teliospores of *Puccinia pulvinata* Rab. on *Echinops niveus* (from Stewart *15786A*); 6, teliospores of *Puccinia* sp. on *Iris Aitchisoni* (from Stewart *15838A*); 7, one teliospore of *Puccinia longirostris* Kom. on *Lonicera asperifolia* (from Stewart *20310*); × 800.

*Puccinia melasmioides Tranz., *Aquilegia vulgaris* L. var. *alpina* H. & T., below Kun Patthar, Aug. 14, 1939, *18488, 18517;* Chillam below Burzil Pass, Aug. 25, 1939, *18971.*

Puccinia Menthae Pers., *Mentha sylvestris* L., Titwal to Surkhala, Kishenganga Valley, July 12, 1939, *17437.*

Puccinia monticola Kom., *Polygonum alpinum* All., Chillam, Burzil Pass, Gilgit Road, Aug. 25, 1939, *18984;* Godai to Chillam, Aug. 25, 1939, *19139.*

Puccinia nitida Barclay, *Polygonum polystachyum* Wall., Banihal Pass, Oct. 5, 1934, *14150B.*

*Puccinia plicata Kom., *Prangos pabularia* Lindl., Lohan Gali near Purana Tilel, Aug. 14, 1939, *18498 bis.;* above Minimarg, Gilgit Road, July 26, 1940, *19798.*

Puccinia Polliniae Barclay, *Strobilanthes Dalhousianus* C. B. Clarke, Landour, Aug. 6, 1934, *14217,* Aug. 5, 1935, *14867,* July 21, 31, 1937, *15907, 15962.*

Puccinia Polygoni-amphibii Pers., *Geranium rectum* Trautv., Tilel Valley to Chorwan, Aug. 16, 1939, *18597; Geranium Wallichianum* Sw., Jabberkhet, Landour, July 22, 1937, *15898,* July 1938, *16886A.*

Puccinia praecox Bubák, *Crepis oligocephala* Sch.-Bip., Banihal Pass, Oct. 4–5, 1934, *14151B.*

Puccinia Prainiana Barclay, *Smilax aspera* L., below Landour, Aug. 23, 1934, *14405.*

Puccinia Prenanthes-purpureae (DC.) Lindr., *Lactuca decipiens* C. B. Clarke, above Chorwan, July 25, 1940, *19729;* Chorwan to Burzil Chowki, July 26, 1940, *19763.*

Puccinia Prostii Moug., *Tulipa stellata* Hook., Abbottabad, April, 1934, *13677;* Margalla, Rawalpindi Distr., Mar. 29, 1936, *15390A.*

The teliospores (FIG. 4) in Stewart's material are more strongly spinulose than in material which I had for comparison (Thümen, Myc. Univ. *437;* Rab. Fungi Eur. *2165*) but agree with the rust as reported and figured by Nattrass (A first list of Cyprus fungi. 87 pp. Nicosia. 1937).

Puccinia pulvinata Rab. *Echinops niveus* Wall., Landour, Dec. 1, 1936, *15786A.*

Accounts in the literature indicate that this is a rather variable species. In Stewart's collection the urediospores are somewhat smaller and thinner-walled than given in most descriptions. Moreover, the teliospores (FIG. 5) are narrower, the wall is distinctly verrucose and the apex is noticeably umbonate. The gross appearance of the telia is typical.

PUCCINIA RUBIGO-VERA (DC.) Wint., *Aconitum rotundifolium* Kar. & Kir., Deosai Plains, July 30, 1940, *s. n.; Actaea spicata* L., Kamri Pass, Aug. 17, 1939, *18648; Anemone tetrasepala* Royle, Rajdhiangan Pass, Gilgit Road, July 19, 1940, *19481; Aquilegia vulgaris* L., subsp. *pubiflora* H. & T., Keran, July 14, 1939, *17618; Aquilegia vulgaris* L. (var.), Burzil Chowki, Gilgit Road, July 27, 1940, *19883; Clematis orientalis* L., Gurikot, Astor Valley, August 1939, *18925; Thalictrum minus* L., var. *majus* H. & T., Khel-Taubat, July 24–25, 1939, *17843.*

PUCCINIA SAXIFRAGAE-CILIATAE Barclay, *Saxifraga ciliata* Royle, above Uri, Jhelum Valley, July 1, 1934, *13923; Saxifraga Stracheyi* H. & T., Thalle La, Baltistan, Aug. 13, 1940, *20599.*

PUCCINIA SWERTIAE Wint., *Swertia petiolata* Royle, above Gulmarg, July 1934, *14033; Swertia speciosa* Wall., above Chorwan, July 25, 1940, *19723; Swertia Thomsoni* C. B. Clarke, Gadsar, Aug. 11, 1939, *18333;* Chillam, Gilgit Road, Aug. 25, 1939, *18890, 18990; Swertia* sp., Pir Panjal Range, July 1934, *13977A.*

PUCCINIA TARAXACI Plowr., *Taraxacum officinale* Wigg., Burzil Chowki, July 28, 1940, *19878, 19975.*

PUCCINIA VIOLAE (Schum.) DC., *Viola biflora* L., Rajdhiangan Pass, Gilgit Road, July 19, 1940, *19509.*

PUCCINIA WATTIANA Barclay, *Clematis grata* Wall., Naranag, Wangat Valley, Aug. 8, 1939, *18122; Clematis* sp., Jabberkhet, Landour, Aug. 16, 1934, *14362;* Dehra Dun, Sept. 1934, *14673.*

*PUCCINIA sp., *Iris Aitchisoni* Boiss., Margalla Pass near Rawalpindi, Mar. 29, 1937, *15838A.*

This collection probably represents an undescribed species but the specimen is so scanty that I prefer not to attach a specific name.

The two groups of sori are caulicolous with the pulvinate, blackish brown telia occurring in a more or less concentric ring around the remnants of the preceding aecial cups. The telia are early ex-

posed and devoid of paraphyses; the teliospores (FIG. 6) mostly clavate or oblong-ellipsoid, 18–27 × (30–) 38–49 μ; the smooth wall is chestnut-brown, 2–3 μ thick at the sides and (3–) 4–7 μ at the apex; the pedicel is persistent, pale yellowish and about as long as the spore.   No aecia in condition for adequate description are present but the peridial cells are variable, globoid, ellipsoid or oblong, 18–23 × 26–38 μ, the inner wall verrucose and 1.5–2 μ thick, the outer wall striate and 4–6 μ thick.   The aeciospores are hyaline, finely verrucose, ellipsoid to globoid, 14–19 × 18–23 μ and with a wall 1–1.5 μ in thickness.   A few irregular and usually somewhat angular urediospores (17–22 × 22–26 μ) were seen, the wall golden-brown, apparently finely verrucose, 2.5–3 μ thick and with three or four pores, variously placed.

*TRACHYSPORA ALCHEMILLAE (Pers.) Fuckel, *Alchemilla vulgaris* L., Deosai Plains between Burzil Chowki and Skardu, July 29, 1940, *20049*.

UROMYCES GERANII (DC.) Fries, *Geranium aconitifolium* L' Her.?, above Chorwan, Gilgit Road, July 25, 1940, *19687; Geranium* probably *grandiflorum* Edgew., Kamri Pass, Aug. 17, 1939, *18646*.

Uromyces Haussknechtii Tranz., *Euphorbia pilosa* L., above Gadsar, Aug. 12, 1939, *18346*.

UROMYCES HEDYSARI-OBSCURI (DC.) Car. & Picc., *Hedysarum cachemirianum* Benth., Kamri Pass, Aug. 18, 1939, *18689*.

*UROMYCES KONDOI M. Miura?, *Gueldenstaedtia* probably n. sp. near *multiflora* Bunge, Rawalpindi, April 1934, *13857*.

Since there are only uredia present in this collection and since only telia were described by Miura this determination can be only tentative.   The host of *U. Kondoi* is *G. multiflora.   Uromyces Gueldenstaedtiae* Liou & Wang is probably synonymous and it, too, has been described only in the telial stage.

The uredia in Stewart's collection are mainly hypophyllous, scattered or frequently with a central sorus surrounded by a ring of secondary sori, roundish, 0.3–1.0 mm. in diameter, pale cinnamon-brown, surrounded by the ruptured epidermis; the urediospores vary from nearly globoid to ellipsoid and measure 15–18 × 18–24 μ; the wall is pale cinnamon-brown, 1.5–2 μ thick, finely echinulate and provided with 4–6 scattered pores.

*UROMYCES LAPPONICUS Lagerh., *Astragalus Maddenianus* Benth., Burzil Pass, Aug. 27, 1939, *19004*.

UROMYCES LYCOCTONI (Kalchbr.) Trotter, *Aconitum laeve* Royle, near Gulmarg, July 11, 1935, *14836;* below Kun Patthar, Aug. 14, 1939, *18510*.

UROMYCES POLYGONI (Pers.) Fuckle, *Polygonum cognatum* Meissn., Burzil Chowki, Aug. 27, 28, 1939, *19101, 19182; Polygonum paronychioides* C. A. Mey., Chorwan to Burzil Chowki, July 26, 1940, *19780*.

UROMYCES PROËMINENS (DC.) Pass., *Euphorbia hispida* Boiss., Titwal, July 10, 1939, *17416*.

The hosts of these rusts were named at the New York Botanical Garden by Dr. R. R. Stewart.

THE ARTHUR HERBARIUM,
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      LAFAYETTE, INDIANA

DERMATEA BICOLOR ON AMELANCHIER [1]

J. Walton Groves [2]

(with 3 figures)

In the fall of 1941, a species of *Dermatea* which was tentatively identified as *D. Brenckleana* (Sacc.) Seaver, was collected on *Amelanchier* at the Petawawa Forest Experiment Station, Ontario. This species was originally described by Saccardo (1920) as a *Patinella* and was transferred to *Dermatea* by Seaver and Velasquez (1933). A part of the type collection of *Patinella Brenckleana* was kindly loaned by Dr. D. H. Linder of the Farlow Herbarium and this proved to be identical with the Petawawa material. A conidial stage belonging to the genus *Micropera* and agreeing with that described by Seaver and Valasquez (1933) was found associated with the *Dermatea,* and cultures from ascospores and conidia proved to be identical and both produced the same conidial stage in culture. The genetic connection was, therefore, considered to be established.

On comparing this material with other species of *Dermatea,* the writer was impressed by its similarity to the fungus described as *Tympanis bicolor* by Ellis (1883). A part of the type collection of this species had been examined in the Durand Herbarium, Cornell University in 1935 and it was unquestionably a species of *Dermatea,* but since the host was not named and the fungus did not agree with any other species known to the writer, it had not been possible to place it satisfactorily at that time.

Although no conidial stage was observed on the Ellis specimen, the apothecia appeared to be morphologically identical with the Petawawa material, so an attempt was made to have the host of the Ellis specimen identified. At the writer's request, Professor H. M. Fitzpatrick had sections made of the wood of this specimen. This was done by Mr. Victor M. Cutter Jr. who expressed the

opinion that the wood was certainly Rosaceous and probably *Amelanchier*. The slides were examined by Professor I. W. Bailey, Harvard University, who confirmed the identification as *Amelanchier*.

It is, therefore, concluded that *Dermatea Brencklcana* (Sacc.) Seaver and *Tympanis bicolor* Ellis are identical, and in view of the fact that *T. bicolor* is the older name, it becomes necessary to make a new combination.
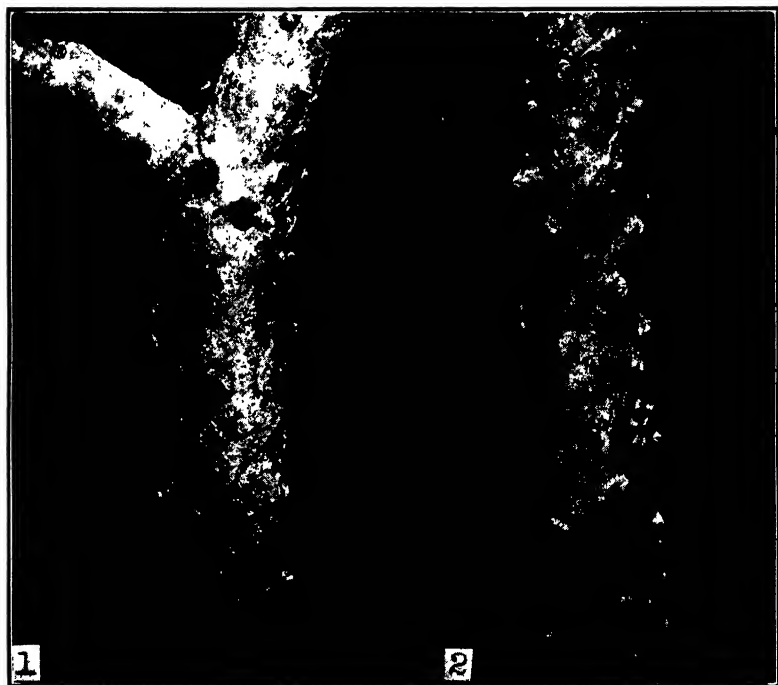
FIG. 1, apothecia of *D. bicolor,* × 4 approx.; 2, conidial stage of *D. bicolor,* × 4 approx.

Dermatea bicolor (Ellis) comb. nov.

  Tympanis bicolor Ellis, Amer. Nat. **17**: 193. 1883.

  Cenangium bicolor Sacc. Syll. Fung. **8**: 557. 1889.

  Cenangium dichroum Sacc. Syll. Fung. **8**: 1143. 1889.

  Patinella Brenckleana Sacc. Mycologia **12**: 203. 1920.

  Dermatea Brenckleana Seaver, Mycologia **25**: 142. 1933.

Apothecia erumpent, gregarious, mostly separate, sometimes in more or less elongated clusters, circular or undulate, sessile, narrowed below, 0.5–1.5 mm. in diameter, 0.5–1.0 mm. in height, at first slightly furfuraceous, yellowish or greenish when moist, finally dark brown to black and glabrous, hard, leathery to horny in consistency, becoming more fleshy-leathery when moist; hymenium concave to plane or slightly convex, greenish when young and moist, drying dark brown to black, slightly roughened, at first with a thick, raised, furfuraceous, yellowish margin which may disappear later; tissue of the basal stroma pseudoparenchymatous, composed of hyaline to yellowish, irregular cells about 5–12 μ in diameter, arranged in more or less vertically to obliquely parallel rows above, thicker walled and darker toward the outside forming a firm excipulum, in the central part becoming more elongated and interwoven, subhymenium a zone of interwoven, ascending, hyaline hyphae about 2–4 μ in diameter; asci cylindric-clavate, tapering below to a short, slender stalk, eight spored, (56)–60–70–(87) $\times$ 8–10 μ; ascospores ellipsoid-fusiform, straight or slightly curved, one or two celled, hyaline, becoming yellowish-brown, irregularly biseriate to uniseriate, (11)–12–15–(16) $\times$ 3.0–4.0–(4.5) μ; paraphyses hyaline, filiform, septate, simple or branched, 1.5–2.0 μ in diameter, the tips scarcely swollen but more or less glued together forming an epithecium.

Conidial fruiting bodies splitting the bark, more or less immersed to slightly erumpent, gregarious, variable in shape, circular to elongated or angular, 0.2–0.8 mm. in diameter, 0.2–0.4 mm. in height, yellowish, furfuraceous, more or less wrinkled, soft, waxy in consistency, becoming more fleshy when moist, containing one to several, more or less lobed cavities which open irregularly and sometimes widely, exposing the greenish to yellowish spore masses; tissue compact, pseudoparenchymatous, composed of hyaline, almost isodiametric to irregular cells about 4–7 μ in diameter, sometimes more elongated and interwoven above; conidiophores lining the cavity, hyaline, cylindric, septate, not observed branching, tapering to a pointed tip, 15–30 $\times$ 1.5–2.5 μ; conidia hyaline, fusiform, sickle-shaped or almost straight, pointed at the ends, one celled, occasionally two celled, (12)–15–20–(25) $\times$ 2.5–4.0 μ; no microconidia observed in nature.

Host: *Amelanchier* spp.

SPECIMENS EXAMINED: Durand Herbarium. *7440, Tympanis bicolor* Ell. Decorah, Iowa. Coll. E. W. Holway (*220*), Aug. 1882. Type.

Farlow Herbarium. North Dakota Fungi—Brenckle *1196*. *Patinella Brenckleana* Sacc. n. sp., on *Amelanchier alnifolia,* Whitestone Gully. Coll. J. F. Brenckle, Oct. 3, 1920. Type.

Mycological Herbarium, Science Service, Ottawa. On *Amelanchier* sp. *7338(715)*,[3] *7512(720)*, *7534(725)*, *7935(768)*, Mason L., Highview, Petawawa Forest Experiment Station, Ontario.

University of Toronto Herbarium. On *Amelanchier* sp. *17324 (412)*, Temagami Forest Reserve, Ontario.
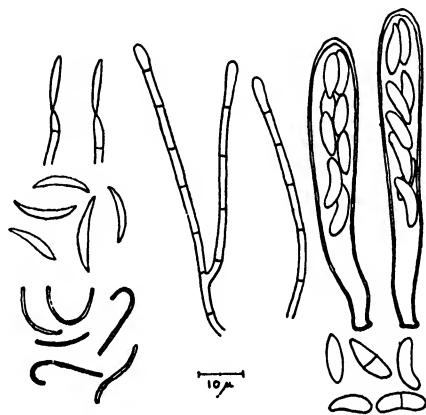
Fɪɢ. 3. *Dermatea bicolor.* Drawings of asci, ascospores, paraphyses, conidiophores, conidia and microconidia.

On malt extract agar the colonies reach a diameter of 5.5–6.5 mm. in three weeks. They are whitish to pale buff with a broad appressed margin and short, more or less tufted, aerial mycelium at the centre. Conidial fruiting bodies develop as more or less circular, rounded, brownish, fleshy stromata, about 1–2 mm. in diameter and 0.8–1.5 mm. in height, glabrous or very slightly tomentose, containing several cavities in the upper part. The cavities are at first globoid, becoming more or less lobed. The tissue is composed of closely interwoven, hyaline hyphae about 3–5 μ in diameter. The conidiophores and conidia are similar to those found in nature. Microconidia have·been observed occasionally in culture, hyaline filiform, one celled, variously curved, frequently more or less hooked at one end, 12–22 × 1.0–1.5 μ.

[3] The numbers in parentheses refer to duplicate specimens in the herbarium of J. W. Groves.

This species is distinguished by its occurrence on *Amelanchier,* the small asci and spores, and the small conidia.   In many respects it is close to *Dermatea Ariae* (Pers.) Tul. which occurs on *Sorbus,* and which was discussed by Groves (**1940**).   The ascospores and conidia are very similar in the two species, and the microconidia in both are rather long and frequently hooked at one end; but the asci rarely exceed 75 μ in length in *D. bicolor,* whereas they are rarely less than 75 μ in *D. Ariae*.   The apothecia of *D. bicolor* are usually a little larger and more strongly erumpent than those of *D. Ariae,* and are greenish to black, not showing the reddish-brown of *D. Ariae*.   The conidial fruiting bodies are also different.   In *D. Ariae* they are more or less conical to flask-shaped, usually fairly uniform in shape, and containing a single cavity.   In *D. bicolor* they are more variable in shape, consisting of an irregular, fleshy stroma containing one to several cavities.   The appearance of the two fungi in culture is also quite different.

D. bicolor probably occurs more commonly than the published records would indicate.   It was found in abundance at Petawawa in 1941 and again in 1942.   The Temagami collection was made in 1935 and consisted of a single small branch lying on the ground and bearing a few apothecia of a *Dermatea*.   It was not possible to identify the host at that time and, since the fungus seemed different from any species of *Dermatea* known to the writer, it was carried in culture as an unidentified species.   When cultures were obtained from the Petawawa material they were recognized as being the same as those from the earlier Temagami collection.   At the writer's request, sections of the wood of this collection were compared with sections of *Amelanchier* by Mr. C. G. Riley, and he stated that they were similar in every way.

This study thus provides a demonstration of the necessity for a careful determination of the host plant when collecting fungi, and also of the value of cultures as an aid to identification.

and examining them; to Professor I. W. Bailey, Harvard University, for final checking of these sections; to Dr. D. H. Linder, Harvard University, for the loan of the type of *Patinella Brenckleana;* and to Mr. C. G. Riley, Division of Botany and Plant Pathology, Science Service, Ottawa, for checking the wood of the Temagami collection.

LITERATURE CITED

Ellis, J. B. New species of North American Fungi. Amer. Nat. **17**: 192–196. 1883.

Groves, J. W. Some *Dermatea* species and their conidial stages. Mycologia **32**: 736–751. 1940.

Saccardo, P. A. Notae mycologicae ser. XXIX. Micromycetes Dakotenses et Utahenses a Doct. J. F. Brenckle Lecti et Communicati. Mycologia **12**: 199–205. 1920.

Seaver, F. J. & Velasquez, J. *Dermea* and *Pezicula*. Mycologia **25**: 139–149. 1933.

A NEW SPECIES OF PHYLLACTINIA [1]

DAVID H. LINDER

(WITH 1 FIGURE)

In his monographic study of the Erysiphaceae, Salmon (1910) recognized but a single species of *Phyllactinia,* one which occurs over a wide host and geographic range. Since that time Blumer (1933), Homma (1937), and others have recognized additional species, varieties, and forms. In examining material collected for the Farlow Herbarium, the writer encountered a specimen on *Eleagnus argentea* Pursh which, although resembling *P. suffulta* in general aspects, produces pronouncedly and consistently larger cleistothecia. The size of the cleistothecia, 247–303 μ in diameter, ranges this species among those segregates of *P. suffulta* (Rebent.) Sacc. [*P. Corylea* (Pers.) Karst. p.p.] that are represented by *P. Salmoni* Blumer [Syn.: *P. imperialis* Homma], *P. Hippophaës* Thuem., and *P. roboris* (Gachet) Blumer, the differences between which are shown in the following table:

Species	Perithecia		Asci		Ascospores
	No. appendages	Diam.	Number	Size	Size
P. Salmoni	10–30	294–362 μ	20–30	80–110×30–50 μ	35–45×20–25 μ
P. Hippophaës .	many	246–272 μ	25–40	70–80 ×25–40 μ	20–35×15–20 μ
P. roboris......	15–30	214–250 μ	15–30	70–90 ×25–35 μ	30–40×19–23 μ
P. suffulta	6–12	160–230 μ	10–30	70–100×25–40 μ	25–40×15–25 μ
P. n.sp........	8–13	247–303 μ	30–35	97–110×34–42 μ	38–47×19–23 μ

A comparison of the species on *Eleagnus* with others listed in the above table shows that while its cleistothecia fall within the size classes of *P. Salmoni* and *P. Hippophaës,* it nevertheless differs from these two species by the smaller number of appendages that are produced and by the somewhat larger though proportionately

[1] Contribution from the Laboratories of Cryptogamic Botany and the Farlow Herbarium, Harvard University, no. 222.

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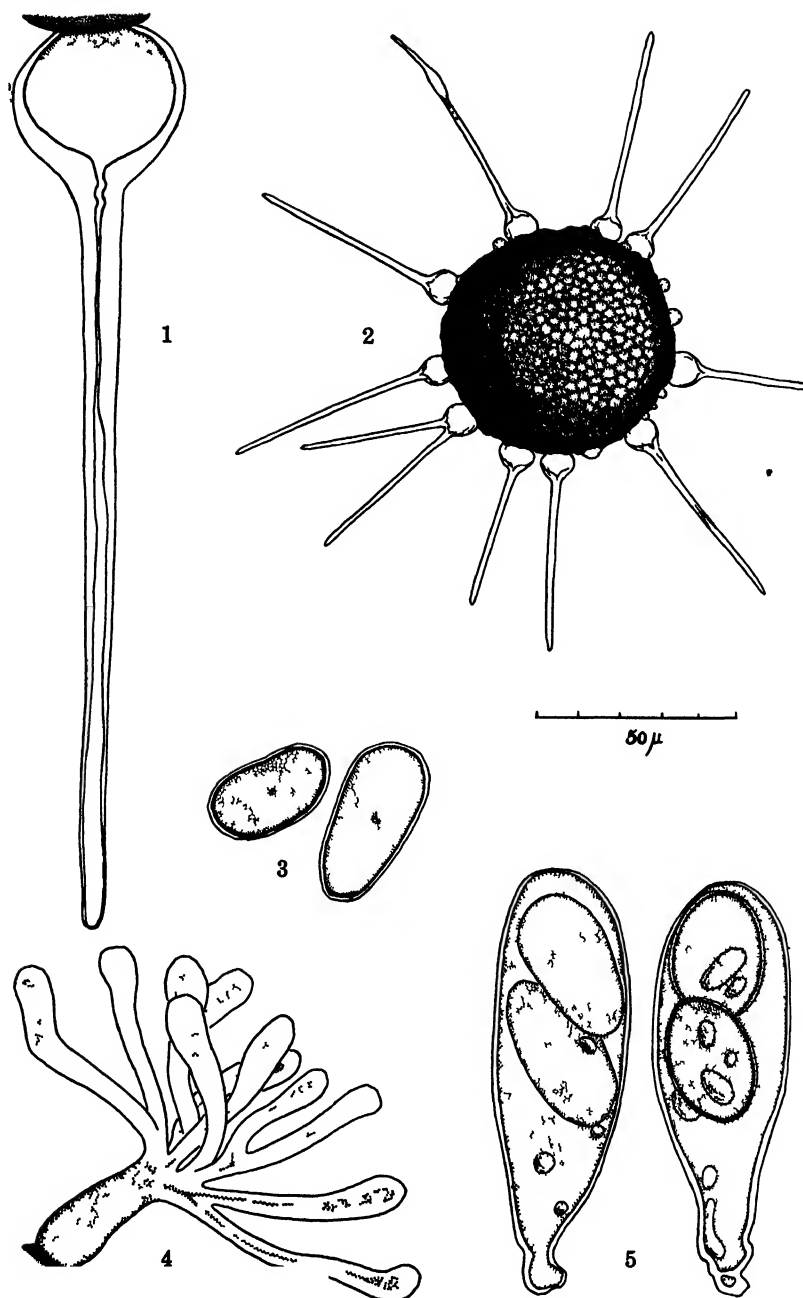
FIGS 1–5 *Phyllactinia Fleagni* Linder

narrower ascospores.   In addition, there is the added distinction
that the asci and ascospores are strongly colored by the presence of
a greenish-yellow pigment, but there is reason to suspect that the
pigment may not be too stable a character since it tends to bleach
on standing in potassium hydroxide.   Since, however, the speci-
mens were six years old when first studied and the pigment was
very conspicuous, more conspicuous than in equally recent collec-
tions of *P. suffulta,* it seems worthy of mention as a character that
may be of taxonomic value.   In view of the characters mentioned
previously, and also because Blumer (*l.c.*) has shown by biometric
studies which have been supported by the inoculation experiments
of Hammarlund (1925) that there is a greater degree of specificity
among the Erysiphaceae than has been previously acknowledged,
it seems desirable to recognize this fungus as a new species and for
it the following formal description is given:

Phyllactinia Eleagni Linder, sp. nov. (FIGS. 1–5.)

Cleistotheciis nigris, 247–303 μ diametro, plerumque hypophyllis; appen-
dicibus 8–10–(13), leniter brevioribus vel longioribus quam cleistothecia,
apicem rotundatum versus nonnihil attenuatis; ascis bisporis, 30–35 in cleisto-
thecio, 97–110 × 34–42 μ, protoplasmato a pigmento viride-luteo colorato;
ascosporis ovoideis vel ellipsoideis, 38–47 × 19–23 μ, protoplasmato a pig-
mento viride-luteo colorato.

Cleistothecia numerous, mostly hypophyllous, black when ma-
ture, 247–303 μ in diameter.   **Appendages** 8–10–(13), slightly
shorter to slightly longer than the diameter of the cleistothecium,
even or occasionally swollen, slightly tapering to a bluntly rounded
apex, occasionally two appendages arising from a single bulbous
base.   **Asci** 30–35 in a cleistothecium, 97–110 × 34–42 μ, 2-spored,
the contents deeply ·stained by a greenish yellow pigment.   **Asco-
spores** large, ovoid to ellipsoid, 38–47 × 19–23 μ, the contents
deeply stained with a yellowish green pigment.

On *Eleagnus argentea* Pursh, upper Wind River, some miles
below Dubois, Fremont Co., Wyoming, August 27, 1936, *George
& Ruth Rossbach, No. 402,* **TYPE.**

LITERATURE CITED

Blumer, S. 1933. Erysiphaceae Mitteleuropas. Beitr. Kryptogamenfl.
      Schweiz 7: 378–402.
Hammarlund, C. 1925. Zur Genetik, Biologie und Physiologie einiger
      Erysiphaceen. Hereditas 6: 1–126.

Homma, Y. 1937. Erysiphaceae of Japan. Hokkaido Imp. Univ. Jour. Faculty Agric. **38**: 403–418.

Salmon, E. S. 1900. Monograph of the Erysiphaceae. Torrey Bot. Club Mem. **9**: 224–236.

EXPLANATION OF FIGURES

FIGS. 1–5. *Phyllactinia Eleagni* Linder. *1*, a typical appendage, slightly tapering to the abruptly rounded apex; *2*, a characteristic cleistothecium with ten appendages (one branched) and also showing the aborted appendages represented by the scattered light-colored cells on the margin; *3*, ascospores; *4*, a penicillate cell; *5*, two asci, the right hand one containing two fully differentiated ascospores (figs. 1, 3–5 approximately × 460, fig. 2 approximately × 91).

MYCOLOGICAL NOTES. VII

C. L. Shear

29. Mycosphaerella Grossulariae and M. Ribis

The question arises as to the correct name to apply to the leaf spot fungus on *Ribes rubrum* and other species of *Ribes* in this country. The current usage here is *Mycosphaerella Grossulariae* (Fries) Lind. This was used by Stone (Phytopath. 6: 109, 419. 1916) for the American fungus, which he proved was the perfect stage of a *Septoria* which he referred to *S. Ribis* Desm. He also showed by inoculation experiments, that the fungus infects *Ribes rubrum, R. nigrum* and *R. Grossularia.*

The specific name *Grossulariae* Fries was originally used by him for *Sphaeria Grossulariae* (Syst. Myc. 2: 521. 1822). Later (Summa Veg. Scand. 394. 1849) he also lists it as *S. (Sphaeria) Grossulariae* under section *Sphaerostomae,* citing his Scler. Suec. Exs. no. 57 and adding "Potius Diplod." Fuckel seems to have been the first to report on a microscopic examination of Fries' specimen of this number. He states (Symb. Myc. 133. 1869) that Fries' plant is a *Pleospora* which he calls *Pleospora Grossulariae* (Fries) Fuckel. Berlese (Icon. Fung. 2: 20, *pl. 27.* 1900) makes this a synonym of *Pleospora herbarum* (Pers.) Rab. We have examined two specimens of Fries no. 57 and find on both only a *Pleospora* which agrees with *P. herbarum.*

Klebahn also regards Fries' plant as *P. herbarum.* How did the application of Fries' name to a *Mycosphaerella* arise? It apparently began with Auerswald who transferred Fries' name *Grossulariae* to *Sphaerella* as *S. Grossulariae* (Fries) Auers. Citing Fries Scler. Suec. no. 57 and Rab. Herb. Myc. (1st ed.), no. 1563 Auerswald's description (Gonnerman and Rabenhorst Myc. Europ., pt. 5, 11. 1870) is of a *Mycosphaerella* and was evidently based on the Rabenhorst specimen (no. 1563). There is no proof that he found such a fungus on the Friesian specimen he cites, though it is possible that the leaf in the specimen may have shown

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both *Pleospora* and *Mycosphaerella*. If so, Fries' description should have made it clear which fungus he was naming. Notwithstanding Fuckel's work Winter (in Rab. Krypt.—Fl. 1²: 387. 1885) followed Auerswald and Lindau later (in Engler—Prantl Nat. Pflanzenfam. 1: 424. 1897) transferred the name to *Mycosphaerella* as *M. Grossulariae* (Fries) Lind.

Klebahn (Haupt—und Nebenfruchtformen der Askomyceten 61–72. 1918) discusses these species under the head of *Mycosphaerella Ribis,* describes the life cycle and concludes that *Sphaerella Grossulariae* Auers. (l.c.) not *Sphaeria Grossulariae* Fries, is the same as *M. Grossulariae* (Fries) Lind. He confirms Stone's finding of two years earlier that *Septoria Ribis* Desm. is the pycnidial stage but does not mention his paper, which due to the interference of the first world war he probably had not seen. Since Fries' name *Grossulariae* is untenable, having been applied to an entirely different fungus, *Pleospora,* Klebahn adopts the name *M. Ribis* (Fuckel) which he regards as a synonym of Auerswald's *Sphaerella Grossulariae* and *Mycosphaerella Grossulariae* Lind. not *Sphaeria* Fries, though he points out the great variability in the perithecia as well as the pycnidial forms on the various species of *Ribes* and calls attention to the need of much further study to determine the validity or synonymy of the various names that have been used. We agree with Stone (l.c.) that *Sphaerella Ribis* Fuckel is a very doubtful synonym of *S. Grossulariae* Auers. and *Mycosphaerella Grossulariae* Lind. Fuckel says (l.c.) that *S. Ribis* has perithecia on the *upper* side of the leaves and that the ascospores are 16 by 4 μ. The various specimens of *Mycosphaerella* on *Ribes* from Europe and America which we have examined have the perithecia all on the *under* side of the leaves and the ascospores according to our measurements are 21–27 by 3 μ. Auerswald gives 27 by 3 μ, Stone 28–35 by 3–4, and Klebahn 18–26 by 3–3.5. Klebahn's shortest spores were 18 μ. Until someone examines Fuckel's type specimen and confirms or corrects his description we do not feel justified in citing *Sphaerella Ribis* Fuckel as a synonym of *S. Grossulariae* Auers. In the meantime *Sphaerella Grossulariae* Auers. or *Mycosphaerella Grossulariae* (Auers.) Lind. seems to be the most certain appelation for the common currant and gooseberry leaf spot fungus. The transfer of Fuckel's

Sphaerella Ribis to *Mycosphaerella* seems to have been made first by Feltgen (Vorst. Pilzflora Luxemb. **1**: 285. 1899) and not by Jaap. (Verh. Bot. Ver. Prov. Brand. II: **49**: 14. 1907) as sometimes cited. *M. Ribis* (Fuckel) Felt. would therefore be the correct citation.

Sphaerella Grossulariae Auers. not Fries (l.c.), as shown by an examination of a specimen of No. 1563 Rab. Herb. Myc. Exs. 1st ed. which he cites as representing his plant, was kindly supplied by Dr. Linder from the Farlow Herbarium. This agrees entirely with Auerswald's description and is the plant which Lindau (l.c.) transferred to *Mycosphaerella*. In a so-called new edition of Rabenhorst's Herb. Myc. Exs. no. 251 is supposed to be the same species. It is labelled *"Sphaeria Grossulariae* Fr. Ad Grossulariae ramulos siccos."* Some of the sets of this 2d ed. of Rabenhorst are said to be spurious and this is evident from the fact that one set with this number and name is *Dothidea ribesia* on *Ribes* twigs and the other with the same number and name is *Mycosphaerella Grossulariae* (Auers.) Lind. on a leaf of *Ribes*.

According to our present information the perfect stage of our currant and gooseberry leaf spot fungus, *Septoria Ribis* Desm., is *Mycosphaerella Grossulariae* (Auers.) Lind. Whether *M. Ribis* (Fckl.) Felt., which Klebahn regarded as the same, is a form of the same species or a separate one seems uncertain at present.

30. SPHAERIA MELASTOMA FRIES

This species was first described by Fries (K. Vet. Akad. Hand. **38**: 90. 1817) as follows:

"Sphaeria melastoma, tecta convexa, linea nigra et superne epidermide stroma albidum arcte includentibus, sphaerulis paucioribus ovatis immersis, collis in disco erumpenti-elliptico planiusculo atro subexsertis minutis sparsis hemisphaericis.

Vexer pa qvistar af vild Appel.

Hvarje varta gor barken rundt ikring blekare och dess betachning bildas mest af barkens ofverhud, hvarfore den star foljande afdelning nara. Fastet arhvitt. Disken svart, icke dess mindre tror jag den komma *Sph. Nivea* narmast. Hylshusen kring 6 till antalet, tamligen stora, agglika. Oppningarne atskiljas endast med bevapnadt oga."

In 1823 (in Kunze and Schmidt Myc. Heft. **2**: 44), Fries published another description as follows:

"47. *Sphaeria* (Ser. II. Sect. 4. a) *melastoma:*
Tecta convexa, stromate albo, linea nigra et superne epidermide arcte incluso, peritheciis simplicibus ovatis collis elongatis in disco erumpenti-elliptico plano atro prominulis hemisphaericis. V. A. H. In ramis emortuis Pyri mali etc."

Later in the same year (Syst. Myc. 2: 388. 1823) he described it again:

"147. *S. melastoma,* convexa, stromate albido arcte incluso, disco sub-elliptico, ex ostiolis minimis hemisphericis stipatis obliterato.
Fries V. A. H. 1817, p. 90 Kunz. Myc. Heft. 2, p. 44.
Inter minores. Conceptaculum ligno subadnatum, epidermide bullata ex-pallente tegente avulsa dimidiatum persistit. Perithecia ovata, pro ratione majuscula. Discus minutus, opacus, niger, ex ostiolis nudo oculo minime discernibilibus. Ad cortices Pyri Mali. Vere. (v.v.)"

In 1849 (Sum. Veg. Scand. 411) he lists this fungus under the genus *Valsa* as follows: "(15) *V. melastoma* Fr. 3–4."

Nitschke (Pyren. Germ. 237. 1869) describes *Valsa melastoma* Fries from an original specimen of Fries' fungus on *Pyrus Malus* found in Kunze's herbarium. In this specimen Nitschke found polysporous asci 30 by 6 μ with subhyaline uni-cellular, slightly curved ascospores, 5 by 3 μ. This specimen was on a branch of *Pyrus Malus,* as stated by Fries. This was the first distinctive description of the species. Later the same year, Fuckel (Symb. Myc. 203. 1869) described the genus *Valsella* and says that *Valsa melastoma* Fries belongs here.

Valsa melastroma Fries is an entirely different fungus from that with which it has been confused on account of the typographic error on Fries' label of his specimen of *Sphaeria melastroma* (Scler. Suec. no. 223) which reads *melastoma* instead of *mela-stroma* as explained above.

Nitschke says the size and form of the stromata of *V. melastoma* show great similarity to *Valsa translucens* De Not. and *V. diatrypa* Fries and among the polysporous spp. to *V. polyspora* Nits.

Sphaeria melastoma Fries was first referred to the genus *Valsella* by Fuckel as mentioned above, though the combination is usually credited to Saccardo (Syll. Fung. 1: 162. 1882).

Karsten (Myc. Fen. 2: 149: 1873) reported and described the fungus as *Valsa melastoma* Fries on *Pyrus Malus* giving the asci as 30–50 by 6 μ and the spores 4–7 by 1 μ, essentially as per

Nitschke. Schweinitz (No. Am. Fun. 201, no. 1341. 1832) reported it on *Malus,* from Bethlehem, Pa. and on the basis of this record Ellis and Everhart (No. Amer. Pyren. 517. 1892) included the species, giving Saccardo's description (l.c.). An examination of a part of Schweinitz' specimen in Michener's herbarium shows an entirely different fungus. Only typical stromata and conidia of *Cytospora ambiens* Sacc. were found. We have seen no other report of the species from this country. From the descriptions and illustrations in Berlese Icones Fungorum (pp. 105–108, *pls. 129–134.* 1905) drawn from type or authentic specimens of the principal species of *Valsella,* it is evident that no morphological characters of specific value have yet been found to separate them. The difference in host plants is not sufficient. *Valsella adherens* Fuckel on *Betula, V. minima* Niessl on *Viburnum, V. padina* Sacc. on *Prunus padus* and *V. Salicis* Fuckel on *Salix* appear to be mere host forms of one species. We are inclined to go a step further and agree with Petrak (Ann. Myc. **17**: 61. 1919) that *Valsella* is probably only a polysporous condition of *Valsa.* He states that he has numerous specimens of *V. polyspora* Nke. on *Betula* in which he found 4 and 8 spored as well as polysporous asci. The 4 and 8 spored asci are known as *Valsa Auerswaldi* Nke. He also found associated with the *Valsella; Cytospora personata* Fries, probably the pycnidial stage of the *Valsella* and *Valsa.* He concludes that *Valsella adherens* Fuckel and *V. polyspora* Nke. are only polysporous forms of *Valsa Auerswaldi* Nke. Berlese (l.c. p. 108) also reports *Cytospora* associated with *Valsella padina* (Saac.) Berl. The conclusion is that *Sphaeria melastoma* Fries is *Valsella melastoma* (Fries) Fuckel which probably has several synonyms and should perhaps be returned to the genus *Valsa* where Fries finally placed it.

31. SPHAERIA MELASTROMA FRIES

Fries (Syst. Myc. **2**: 399. 1822) described *Sphaeria melastroma* as follows:

"173. *S. melastroma,* pustulata, subverrucaeformis, peritheciis aggregatis, disco erumpente angulato nigro obsolete pertuso.
(Scl. Suec. exs. n. 223.)

Habitus S. verrucaeformis & angulatae, sed minus prominet & conceptaculum omnino corticale. Perithecia subsena, erectiuscula, conferta, profunde immersa, verticaliter collabentia. Discus epidermide angulato-fissa erumpens, a cortice interiore formatus, sed superficies plana, laevis, opaca, nigrofacta. Ostiola discum perforant, sed non prominent. Ambigit inter hanc tribum & Versatiles!! In ramis exsiccatis Ulmi. Aut.—vere. (v.v.)"

Fries later (Summa Veg. Scand. 412. 1849) listed this species under *Valsa* as follows: "36. *V. melastroma* Fr. 1. S.S. 223." This is the same number cited with the original description above. Unfortunately the specific name on the label of the specimens of number 223 of his Exsiccati, due evidently to a typographical error, was *melastoma* instead of *melastroma*. To make matters more confusing Cesati and de Notaris (Schem. Class. Sfer. Ital. **32.** 1863) examined a specimen of Fries no. 223 and copied the erroneous name *melastoma* from the label. They give a description of spores found on their specimen of this number as follows: "Sporidia ellipsodiea majuscula, fusco badia 7–8 locularia, loculis pene omnibus septo longitud. dimidiatis." They list it as doubtfully belonging to their genus *Pseudovalsa*.

The next description of a specimen of Fries' no. 223, presumably from the Kew Herbarium, was by Cooke (Proc. Phil. Acad. **122.** 1877) where he uses the correct specific name instead of that on the label as follows: "86. *Valsa melastroma* Fr. S.V.S. p. 412. Schw. Am. Bor. 1358. Sporidia elliptic, uniseptate, brown, .032 × .014 mm. On bark of *Ulmus*, Salem (Schw.). We have seen no American specimen. Character of sporidia given from specimen published by Fries Scler. Suec. 223."

The report of this species by Schweinitz (N. A. F. no. 1358) on elm from Salem, No. Car., is apparently based upon a misidentification of Fries' species. We find no specimen in Schweinitz' herbarium, nor in Michener's. According to the check mark before this name in Berkeley's copy of Schw. N. A. F. he had a part of Schweinitz' collection which is presumably at Kew, but Cooke evidently did not find it. There is, however, in the Curtis collection at Harvard a part of Schweinitz' specimen from Salem. Through the kindness of Dr. Linder we have been able to examine this and find it to bear old small stromata of *Botryosphaeria*. Sections show the typical stromatic characters and locules of this genus. The locules are mostly empty and no *Botryosphaeria*

spores were found. In a few of the old locules there are free spores and hyphae of what is probably a saprophyte, perhaps a *Stemphylium* or *Alternaria,* with light brown muriform spores with 5–6 cross septa, 15–18 by 9–11 μ.

Saccardo (Syll. Fung. 1: 745. 1882) places the fungus in the genus *Valsaria* as *V. melastroma* (Fries) Sacc., citing Fries' original description and his specimen no. 223. He also cites Cooke (l.c.) and gives his description of the spores. From the conflicting reports of de Notaris and Cooke, on two different specimens of this number of Fries exsiccati two quite different fungi were present, as not infrequently happens. The specimen which de Notaris (l.c.) described as a doubtful *Pseudovalsa,* Saccardo (Syll. Fung. 2: 328. 1883) calls *Fenestella melastoma* (Fr. p.p.) Sacc., citing Scler. Suec. no. 223 and giving de Notaris' description of the specimen he examined. Saccardo did not note the typographical error on the label, which should have been *melastroma* and so the two species were confused still further. Winter (in Rab. Krypt.—Fl. 1^2: 743. 1887) has the true *V. melastoma* Fries under the subgenus *Valsella* and also puts under doubtful species of *Fenestella* with a question mark, *F. melastoma* of Saccardo.

On the specimens from four different sets of Fries Scler. Suec. no. 223 which we have examined we find only *Valsaria melastroma* (Fries) Sacc. as reported and described by Cooke (l.c.), who apparently recognized that the name *melastoma* on the label of 223 was a mistake, as is shown by Fries' spelling *melastroma* in his original description and citation of this number.

The fungus found by de Notaris (l.c.) on his specimen of Fries no. 223 and which is referred to *Fenestella* by Saccardo (l.c.) is, according to Berlese (Icon. Fung. 2: 74. 1900), *F. vestita* (Fries). Berlese says he compared an original specimen of *F. melastoma* Sacc. (error for *melastroma*) (Scler. Suec. no. 223) in the Paris herbarium. This confirms de Notaris' record and shows that at least two of Fries' specimens of no. 223 had *Fenestella* as well as probably the *Valsaria* to which Fries' description clearly applies and which we have found on four specimens of this number. The specimens of Fries' type material, Scler. Suec. 223, which we have examined show only small valsoid pustules embedded in the bark of elm branches, with few submembranous

perithecia, with asci 100–150 long, spores overlapping uniseriate, brown, uniseptate, scarcely constricted at the septum, very variable in size, ranging from 22–36 by 12–18 μ, no paraphyses seen.   This is not a good *Valsaria* as typified by *V. insitiva,* but seems more closely related to *Melanconiella.*   Good fresh specimens and a knowledge of its life cycle are needed to determine its true generic and specific status.

The conclusion is that *Sphaeria melastroma* Fries (Scler. Suec. no. 223) is *Valsaria melastroma* (Fries) Sacc. and not *Fenestella melastoma* Sacc. which was found on two specimens by de Notaris and Berlese.

BUREAU OF PLANT INDUSTRY,
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A NEW SPECIES OF TRICHOLOMA

Alexander H. Smith and Maurice B. Walters

(WITH 1 FIGURE)

Tricholoma umbrosum sp. nov. (FIG. 1.)

Pileus 5–9 cm. latus, obtusus vel convexus, siccus, laevis demum areolatus, cinnamomeo-umbrinus; odor et sapor valde distinctus; lamellae latae, adnatae vel subdecurrentes, confertae, cinnamomeo-umbrinae dein rubro-maculatae; stipes 3–5 cm. longus, 1.5–2 cm. crassus, deorsum attenuatus, umbrinus dein rubro-maculatus, solidus; sporae 7–9 × 3–4 μ, amyloideae.—Specimen typicum legit A. H. Smith, prope Truro, Nova Scotia, July 16, 1931 (Wehmeyer n. 640); in Herb. Univ. of Mich. conservatum.

Pileus 5–9 cm. broad, obtuse with an incurved margin at first, becoming broadly convex to plane or slightly depressed in age, surface dry and unpolished, smooth or in age with small areolate patches over or around the disc, not fibrillose scaly, color "drab gray" (dark gray) when young, becoming "cinnamon-drab" (gray, tinged vinaceous) at least on the disc in age; flesh thick, concolorous with the surface, staining reddish where bruised, odor and taste very strong and resembling that of fresh cucumbers; lamellae broadly adnate to slightly decurrent, close, broad, (1 cm. at the stipe), tapered to the margin, concolorous with the pileus but staining reddish readily when bruised, edges somewhat eroded; stipe 3–5 cm. long, 1.5–2 cm. thick at the apex, equal downward but constricted at the base and with a more or less distinct pseudorhiza, solid, more or less concolorous with the pileus, staining reddish where bruised, apex slightly fibrillose-pruinose.

Spores 7–9 × 3–4 μ, narrowly ellipsoid to slightly curved in one view, white in mass, amyloid, smooth or under oil immersion appearing slightly reticulate when mounted in chloral hydrate iodine solution; basidia four-spored; pleuro- and cheilocystidia not differentiated; gill trama homogeneous, subparallel to interwoven, the hyphae of narrow cells, yellowish to reddish in iodine, lactiferous hyphae present; pileus trama homogeneous beneath an interwoven surface layer of hyphae 10–12 μ in diam., these hyphae having dark mummy brown walls (revived in KOH), clamp connections present, tramal body of hyaline compactly interwoven hyphae the same size as or smaller than those on the surface, these sometimes vinaceous red when treated with iodine.

Gregarious under spruce in a pasture, Colchester County, Nova Scotia, July 16, 1931 (Wehmeyer no. *640*) ; under conifers, Newfound Gap, Great Smoky Mountains National Park, N. C., Aug. 17, 1938, A. H. Smith no. *10,301;* near hemlock trees, Cleveland Heights, Ohio, July 7, 1942, Maurice B. Walters.
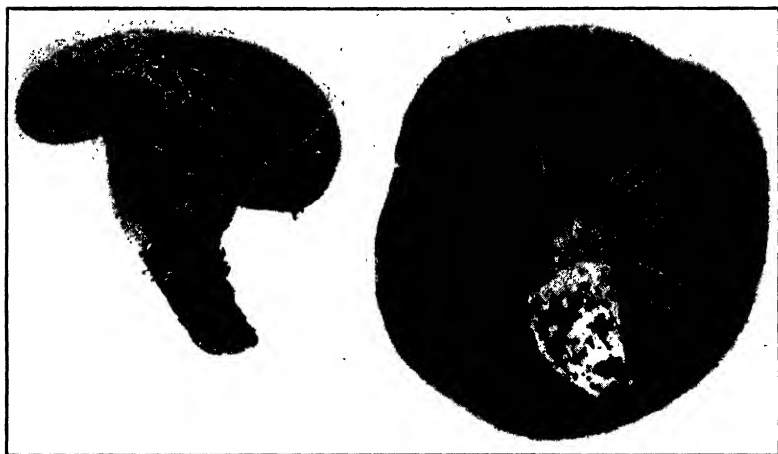
Fig. 1. *Tricholoma umbrosum* Smith & Walters. × ½.

Observations: The taxonomic position of this very curious species is somewhat in doubt. The amyloid spores exclude it from either *Tricholoma* or *Clitocybe* if these genera are regarded in the modern restricted sense, but it cannot be referred to *Melanoleuca* (restricted sense, non Murrill) for obvious reasons, namely the smooth or nearly smooth spores, lack of cystidia, and presence of clamp connections to say nothing of its general appearance. In *Leucopaxillus,* where it may eventually be desirable to place it, a new subgenus would have to be erected. It shows no affinities to any of the known smooth spored species of that genus. Singer, to whom material was sent for examination, thought that it might belong in *Cantharellula,* but even there it did not appear to have any discernible relationships. We have described it in *Tricholoma* in order to place it on record. It bears a certain superficial resemblance to the fleshier species of the *Tricholoma terreum* complex, but the surface of the pileus instead of appearing to be covered with radially arranged fibrils has the unpolished appearance of a

Leucopaxillus.   The vinaceous reaction of the flesh to iodine is sporadic, and, in a series of six mounts, was found to be unreliable. The spores nearly always appear slightly reticulate in mounts in iodine because the very thin wall tends to remain wrinkled in the immature spores, and these are usually very numerous in mounts from dried pilei.   The large well filled out spores appeared to be smooth.   The photograph was taken by Mr. Walters.   The Ohio collection differed from the type in having deeply emarginate gills, paler flesh and slightly shorter spores.   These characters may, along with a possible difference in habitat, eventually be found to distinguish a variety of the species.   At present the differences are regarded as merely variations between collections.   The difference in the color of the flesh may be only that between young and old specimens, and the slight difference in the length of the spores is hardly significant.

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CERCOSPORA ON MORINDA ROYOC

ANNA E. JENKINS AND CHARLES CHUPP

(WITH 1 FIGURE)

Two specimens of *Cercospora* on *Morinda Royoc* L. from Florida
are available, and one from Haiti. Comparison of the fungus from
these sources with type material of *C. Morindae* Syd.[1] on *M. tinc-
toria* Roxb. from Coimbatore, Madras Presidency, India, shows
that the two are distinct species. The *Cercospora* from Florida
and Haiti appears to be unlike any other species of the genus de-
scribed on Rubiaceae. It is described as new, therefore, as
follows:

Cercospora morindicola sp. nov. (FIG. 1)
Leaf spots subcircular to irregular, pinkish buff to orange cinna-
mon; fruiting amphigenous, chiefly epiphyllous, in more or less
concentric arrangement; stroma medium dark, 30–80 μ; fascicles
dense; conidiospores pale to medium dark, tortuous, septate, some-
times branched, 2.5–5 $\mu \times$ 10–60 μ; conidia subhyaline to pale
olivaceous, obclavato-cylindric, very slightly attenuated, straight to
mildly curved, 1–5 septate, base abconically truncate, tip obtuse to
conic, 2.5–4 $\times$ 20–55 μ.

Caespituli densi, amphigeni praecipue epiphylli, in maculis subcircularibus
vel irregularibus e roseo-alutaceis aurantio-cinnamomeis plus minusve con-
centrice dispositi, e stromatibus subfuscis 30–80 μ in diam. oriundi; conidio-
phori pallidi vel subfusci, tortuosi, septati, interdum ramosi, 2.5–5 μ lati, 10–
60 μ longi; conidia e subhyalinis pallide olivacea, recta vel subcurvula, 1–5-
septata, basi obconice truncata, apice obtusa vel conica, 2.5–4 μ lata, 20–55 μ
longa.

Host: Leaves of *Morinda Royoc* L.
Distribution and specimens examined: Key Largo, Florida, 1931,
M. F. Barrus; United States Plant Introduction Grounds, Coco-
nut Grove, Florida, Feb. 13, 1941, J: E. Fennell· *1345* (Type);
Haiti, March 1920, E. C. Leonard *3195* (U. S. Nat. Herb.
1075461).

[1] Sydow, H. Beiträge zur Kenntnis der Pilzflora des südlichen Ostindiens
II. Ann. Myc. 12: 485–590. 1914. Description on p. 490.
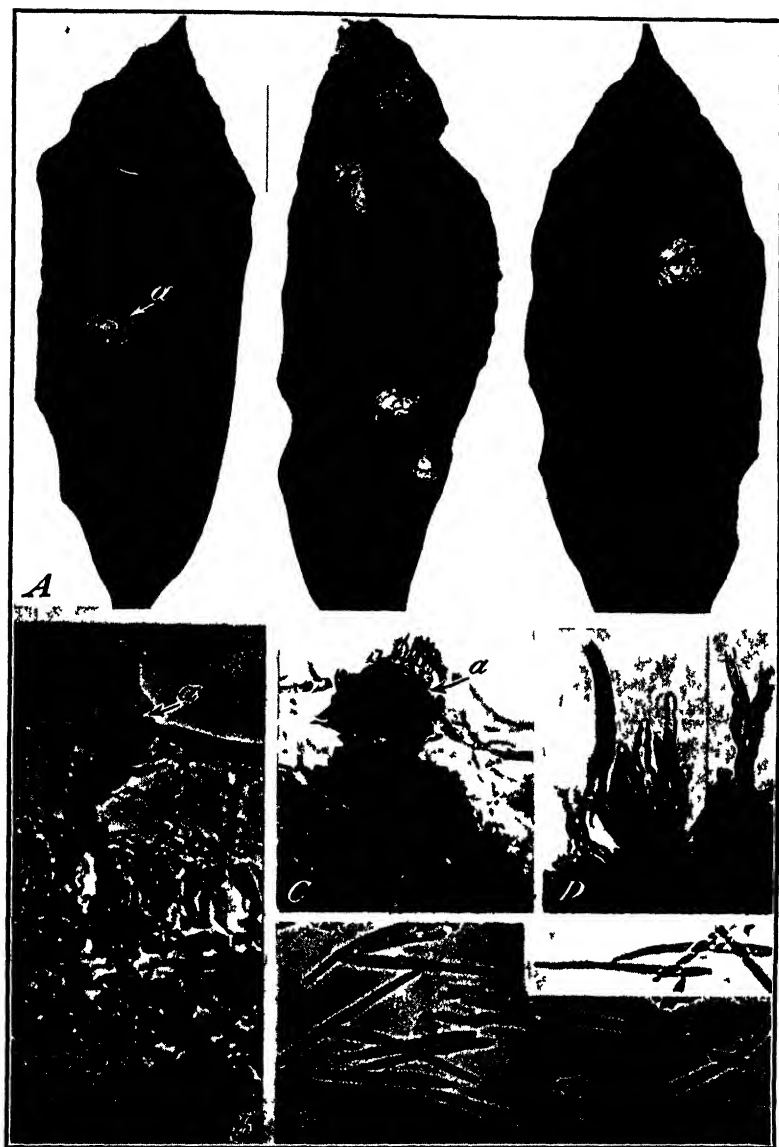
FIG 1 *Cercospora morindicola* on *Morinda royoc* Pine woods Coconut Grove, Fla Feb 21 1941, J E Fennell *1* three leaves showing leaf spots, fruiting arranged more or less concentrically × 1 *B* section through the leaf, fruiting shown at *a* and *b* × 250, *C* a large stroma × 300, *D* conidiophore fascicles, *1* conidia × 500, photographs by W R Fisher (*A* and *D*) and M L F Foubert (*B*, *C*, and *L*)

The type specimen of *Cercospora Morindae* is at the Riks Museum at Stockholm, Sweden, where it was examined in 1938 by the junior writer, who already had been sent a fragment of the material. As compared with *C. morindicola,* this species produces large irregular to rust brown spots, with the fruiting plainly amphigenous. The stroma is pale, 10–30 μ; conidiophores are subhyaline to very pale olivaceous, plainly attenuated, straight, continuous and not branched, 2–3 $\times$ 5–15 μ, bearing cylindro-obclavate conidia 2–3.5 $\times$ 15–65 μ.

Relative to the host of *Cercospora morindicola* the following excerpt is filed with a specimen in the United States National Herbarium collected by A. H. Curtis:

"There is a shrub on the Keys and on the west shore of Bay of Biscayne called "Wild Coffee" but it is neither coffee nor (what I predicted) Glottidium, but a West Indian shrub in the Coffee Family named Morinda Roioc (a specimen of which will be in my next winter's fascicle of S. Florida plants). Although the people of that region call it Wild Coffee, yet the decoction of the leaves which they use they call tea. It is quite popular among the Coonties, but it is no better to my taste than many similar herb teas."

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THE GENUS PHAEOSEPTORIA ON GRASSES IN THE WESTERN HEMISPHERE [1]

RODERICK SPRAGUE [2]

(WITH 2 FIGURES)

Phaeoseptoria Speg. was described by Spegazzini (**6**, p. 39) in 1908 as follows: "*Char.* Est Septoria sporulis olivaceis distincta." In this new genus Spegazzini described one species, namely, *P. Papayae.* In 1909, Miyake (**3**, p. 136) described *P. Oryzae* on rice (in Japanese), and in 1910, he (**4**, p. 260) republished the description in German and added illustrations (**4**, *pl. 14, figs. 61–63*). In 1913, Saccardo and Trotter (**5**) recognized the genus and listed the two species, *P. Papayae* Speg. and *P. Oryzae* Miyake. In this connection, Saccardo and Trotter (**5**) amended the description of the genus *Phaeoseptoria* Speg. as follows: "Pycnidia subcutaneo-erumpentia, nigricantia, minuta. Sporulae bacillares v. anguste fusoideae, coloratae.—Est quasi Septoria sporulis olivaceis distincta." In 1925, Tehon and Daniels (**11**, p. 245) described and illustrated *P. Caricis* on *Carex* sp. from Illinois. The writer agrees with Saccardo's emendation and gives the following key to segregate *Phaeoseptoria* from certain other genera of the Sphaeropsidales:

A. Spores lengthened, at least 10 times as long as
    broad, usually at least 15 times as long........ (Scolecosporae)
    B. Spores hyaline or chlorinous................ *Septoria* Sacc.
    BB. Spores yellowish to light brown, usually stout,
        multiseptate............................ *Phaeoseptoria* Speg.

AA. Spores broadened, usually less than 10 times as
    long as broad, cylindrical to fusoid
    B. Spores 1-septate.......................... (Didymosporae)
        C. Spores hyaline or yellow............... *Ascochyta* Lib.
        CC. Spores brown.......................... *Diplodia* Fries
    BB. Spores 2- or more septate.................. (Phragmosporae)
        C. Spores hyaline........................ *Stagonospora* Sacc.
        CC. Spores colored........................ *Hendersonia* Berk.

Phaeoseptoria, therefore, has longer and usually paler spores than *Hendersonia,* which is an affinity of *Stagonospora.* *Phaeoseptoria* is readily distinguished from *Septoria* by the black, heavy walled, scattered, not so often maculicole, subcutaneous, less often strongly erumpent pycnidia and the stout, multiseptate, lightly colored spores. The species discussed are as follows:

Phaeoseptoria Elymi sp. nov.

Maculis fuscis, pycnidiis sparsis, 180 μ, globosis, erumpentibus, brunneis, ostiolatis (8 μ); pycnosporulis fasciculatis, curvulis, nec recurvulis, bacillari-filiformibus, utrinque obtusatis, 8–14 septatis, fuligineis, 50–75 × 2–2.5 μ.

Hab. in foliis languidis, *Elymi virginici.* Calloway, Nebr.

This fungus was found on *Elymus virginicus* L. in Rev. J. M. Bates' collection No. 2601 at Calloway, Nebr., September 10, 1900, and which is filed in the Mycological Collections, Bureau of Plant Industry, Washington, D. C. This fungus is readily distinguished from the other species of *Phaeoseptoria* by the uniformly bacillar-filiform spores, which are blunt at each end and which scarcely taper and are not swollen at the ends as in some species (FIG. 2, *D*).

Phaeoseptoria Airae (Grove) and P. Phalaridis (Trail)

In a contemporary article (9) we have discussed *Septoria Bromi* var. *Alopecuri* Karst. The description by Karsten (2) led Trail (12) to believe that certain fungi he had seen were related to *S. Bromi* var. *Alopecuri.* Grove (1), followed Sydow (10) and used the name *S. Alopecuri* Syd., but otherwise followed Trail's (12) description. Grove listed *S. Alopecuri* as having hyaline to faintly yellowish spores 45–75 × 2.5 μ. *Septoria Alopecuri* var. *Airae* Grove was described as having fusoid, cylindrical, pale yellowish spores, 60–75 × 2.5 μ. *Septoria Alopecuri* var. *Phalaridis* (Trail) Grove (1) (*S. Bromi* var. *Phalaridis* Trail (12)) was described

as having spores 53–65 $\times$ 3.5–4 μ, 8–15 septate, and *S. Alopecuri* var. *Calamagrostidis* Grove as having yellowish spores, 40–100 $\times$ 3–4 μ, 3–13 septate.

The variety *Airae* has been seen (FIG. 1, *G*). The pycnidia are 130–192 μ in diameter and contain stout clavulate spores with pointed apices and rounded blunted bases. They are obscurely 9 to 10 septate, 51–56 $\times$ 3.0–3.5 μ and are the same as material on *Deschampsia caespitosa* (L.) Beauv. from Oregon (O.S.C. 809). This fungus is very clearly a species of *Phaeoseptoria* and should be known as **Phaeoseptoria Airae** (Grove) comb. nov.

W. B. Cooke collected material of a *Phaeoseptoria* on *Phalaris arundinacea* L. at Corvallis, Oreg. (O.S.C. *17*), which has stout sphaerical pycnidia composed of light golden brown, large celled mycelia from which cuspidate pycnophores arise from creeping hyphae (FIG. 1, *F*). The spores are 8 to 13-septate (FIG. 1, *A*), fiiliform, 70–90 $\times$ 2.5–4.4 μ, somewhat constricted at the septa. This fungus differs, therefore, in several respects from *P. Airae* and from any concept of *S. Bromi* var. *Alopecuri* Karst. It is similar to Trail's *S. Bromi* var. *Phalaridis* (*12*) although the Oregon material has longer spores. We are considering them the same species and propose **Phaeoseptoria Phalaridis** (Trail) comb. nov.

In connection with *P. Phalaridis*, we examined material of *Stagonospora arenaria* Sacc. on *Phalaris arundinacea* collected by Grove on the banks of the Usk River, England, August 20, 1929. This is not our concept of *Stagonospora*, but is closer to *Hendersonia crastophila* Sacc. The spores (FIG. 2, *F*) are brown, fusoid, elongate to clavulate, 40–50 $\times$ 2.9–4.2 μ, 6 to 7-septate. However, these spores are about 12 times as long as broad and technically this would place the fungus in *Phaeoseptoria*. This case simply emphasizes the complexity of the group and the need for flexible classification. The very large pycnidia (250 μ) are diffecent also from those in some collection of *H. crastophila*. Therefore, the spores are close to *Septoria Alopecuri* as interpreted by P. Sydow (**8, 10**), but the pycnidia are not. On the basis of present knowledge, we place these fungi with spores 40–50 μ long in *H. crastophila* and not in *Phaeoseptoria*.
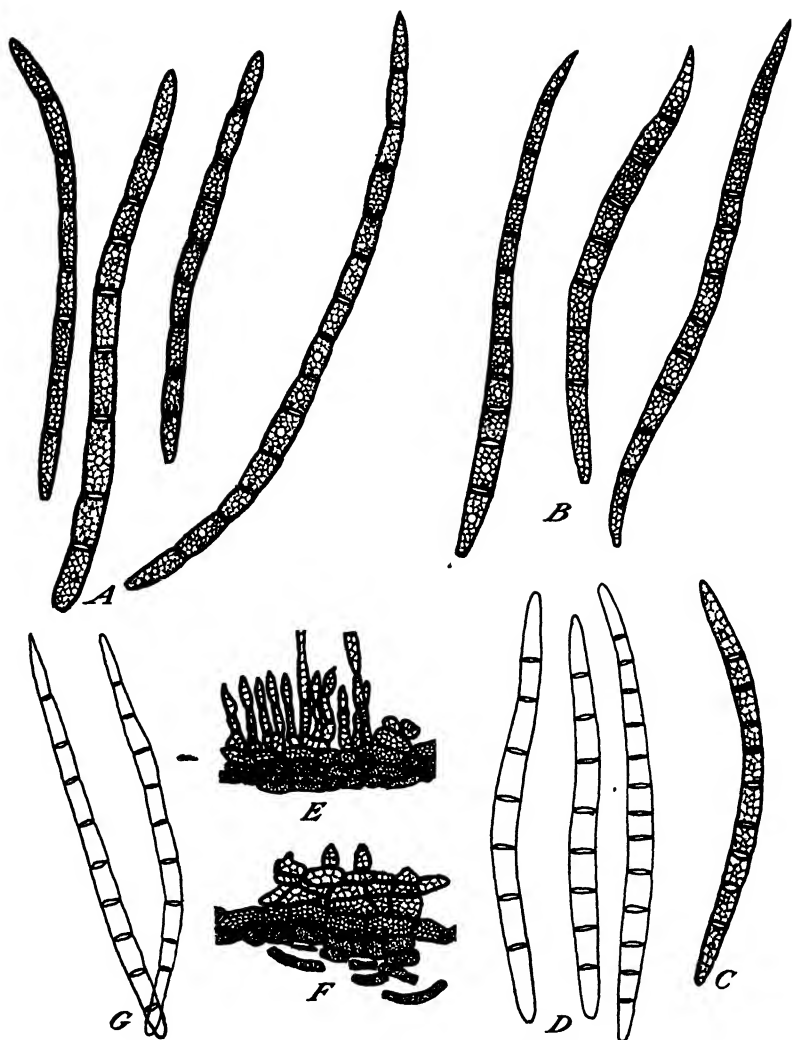
Fig. 1. *A*, pycnospores of *Phaeoseptoria Phalaridis* (Trail) Spr. on *Phalaris arundinacea* L., Corvallis, Oreg., O.S.C. *17; B*, pycnospores of *P. Festucae* Spr. on *Festuca rubra* L., Garibaldi, Oreg., O.S.C. *8376* (Type); *C*, pycnospores of *P. Festucae* on *F. rubra*, King's Valley, Oreg., O.S.C. *202; D*, pycnospores of *P. Festucae* var. *Muhlenbergiae* Spr., Lansing, Mich., H. H. Hicks No. *1211* (Type); *E*, segment of a cross section of the pycnidial wall of *P. Festucae* on *Festuca rubra*, Garibaldi, Ore., O.S.C. *8376* (Type); *F*, segment of a cross section of the pycnidial wall of *P. Phalaridis* on *Phalaris arundinacea* L., Corvallis, Oreg., O.S.C. *17; G*, pycnospores of *P. Airae* (Grove) Spr. on *Deschampsia caespitosa*, Sneyd's Coppice, Worcestershire, England, W. B. Grove, March 7, 1928. [All × 1000.]

Phaeoseptoria Calamagrostidis sp. nov.

Maculis stramineis v. nullis, pycnidiis rariis, nigris, 200 μ diam., erumpentibus, globosis, ostiolatis; pycnosporulis clavulato-filiformibus, aureo-brunneis, subvermiformibus, 5–11-septatis, 55–71 × 4.3–5.0 μ.

Hab. in foliis dejectis *Calamagrostidis nutkaensis* et *Agrostidis palustris* prope maris Pacifici Waldport et Newport, Oregon.

Spots few, scattered, straw colored or none, pycnidia few, scattered, black, heavy walled, subcutaneous, ostiolate, 200 μ diameter, pycnospores clavulate-filiform, somewhat vermiform with softly blunted ends, scarcely constricted at the septa, light yellow brown, 5 to 11-septate, 55–71 × 4.3–5.0 μ (FIG. 2, *C*).

In necrotic overwintered leaves of *Calamagrostis nutkaensis* associated with a multiseptate species of *Leptosphaeria* along the seashore at Waldport, Oreg. (Type, O.S.C. *354*) and on *Agrostis palustris* Huds., Newport, Oreg.

Efforts to locate *Septoria Alopecuri* var. *Calamagrostidis* Grove have been without success as reported earlier (**8, 9**). It appears that proof of the existence of this fungus is lacking and that Grove's description (**1**) possibly may be based on a compilation. His drawing of this fungus is closer to *P. Phalaridis* (Trail) Spr. than the vermisporous *P. Calamagrostidis* which we have described above. It must be emphasized that Grove was probably dealing with a fragment just as our material of *P. Calamagrostidis* is such a fragment. This saprophytic, probably widely scattered but never abundant fungus is evidently of no economic importance and will be encountered only by students critically studying diseases of Gramineae.

Phaeoseptoria Festucae sp. nov.

Pycnidiis globosis v. subglobosis, nigris, subcutaneis, tarde ostiolatis, 55–100 μ lat. × 50–90 alt. (140–160 μ hab. *Danthonia*), contextu brunneo- parenchymatico, 13 μ crasso; pycnophoris pyriformibus, 3–4 × 1.4–1.7 μ; pycnosporulis 50–85 × 2.8–4.8 μ, 8–11-septatis, flavidis, clavato-filiformibus.

Hab. in foliis dejectis *Festucae rubrae* L. (typus) et *Danthoniae Parryi* Scribn.

Pycnidia globose to subglobose, black, suberumpent, sunken, tardily ostiolate, 55–100 μ wide × 50–90 μ high (140–160 μ diameter on Danthonia), walls 13 μ thick with an outer brown portion of closely woven elongated cells totalling 5–6 μ thick, inner hyaline layer (FIG. 1, *E*) radiating towards the pycnophores, which are 3–4 × 1.4–1.7 μ, pyriform, sometimes constricted at the base and
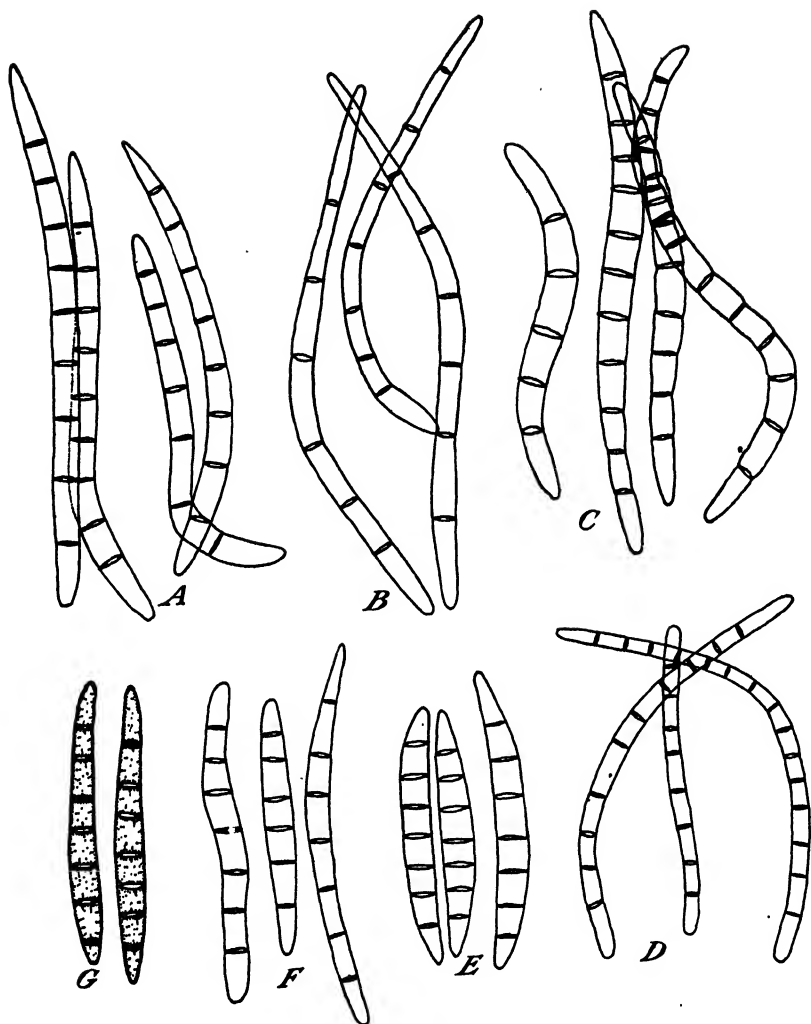
FIG. 2. *A*, pycnospores of *Phaeoseptoria Festucae* on *Danthonia Parryi*, Tolland, Colo., E. Bethel, Sept. 3, 1910; *B*, pycnospores of *P. Urvilleana* (Speg.) Spr. on *Panicum urvilleanum*, Argentina, from type of *Septoria urvilleanum* Speg.; *C*, pycnospores of *P. Calamagrostidis* Spr. on *Calamagrostis nutkaensis* Presl, Waldport, Oreg., O.S.C. *364* (Type); *D*, pycnospores of *P. Elymi* Spr. on *Elymus virginicus* L., Calloway, Nebr., J. M. Bates No. *2601*, Sept. 10, 1900; *E*, pycnospores of *Hendersonia crastophila* Sacc. on *Deschampsia caespitosa* Baxterley Common, England, W. B. Grove, Oct. 15, 1927; *F*, pycnospores of *H. crastophila* on *Phalaris arundinacea*, banks of. Usk River, Brecon, England, W. B. Grove, Aug. 20, 1929; *G*, pycnospores of *H. crastophila* on *Festuca rubra*, Garibaldi, Oreg., O.S.C. *748*. [All × 1000.]

blunt at the apex; spores formed by elongation and later abscissing leaving a blunt base on the spore, spores 50–85 × 2.8–4.8 μ, 8 to 11-septate, flavid, clavulate-filiform with tapering finally blunt (narrowly truncate) base and tapering, pointed to slightly blunt apex (FIGS. 1, *B, C; 2, A*).

On languishing leaves of *Festuca rubra* L. at Garibaldi, Oreg. (type) (O.S.C. *8376*), facing the open sea, and at King's Valley, Oreg. (O.S.C. *202*); and on *Danthonia Parryi* Scribn., Tolland, Colo. (Bethel).

This is another obscure and economically unimportant semi-saprophyte. It has larger spores than *P. Airae* while the blunt base and sharpened apex of the spores distinguish it from *P. Calamagrostidis*. The method of spore formation and the lack of constriction at the septa distinguish it from *P. Phalaridis*.

At Garibaldi it is associated with the shorter spored *H. crasto-phila* (FIG. 2, *G*) (O.S.C. *748*).

Phaeoseptoria Festucae var. Muhlenbergiae var. nov.

Pycnidia associated with black lesions, scattered to subgregarious, prominent, suberumpent, black, subglobose, ostiolate, parenchymatous, 150–190 μ; pycnospores flavid, obclavate, 7–13-septate, bases obtuse, apices subacute, 47–64 × 3.7–4.5 μ.

Hab. in foilage of *Muhlenbergia mexicana* (L.) Trin., East Lansing, Mich., G. H. Hicks, No. *1211*. No date but old material in the undetermined files of the Mycological Collections, Bureau of Plant Industry, Washington, D. C.

This fungus is very close to *P. Festucae,* but differs in having larger pycnidia and lighter colored spores. The spores are yellow, not far removed from true *Septoria,* but the scattered stout structured pycnidia, and relatively stiff, coarse, if only yellow, spores place this fungus in our concept of *Phaeoseptoria* (FIG. 1, *D*).

The association of this fungus with the tar-spot lesions is confusing. C. R. Orton, in 1940 notations on the packet of Hicks No. *1211,* rejected this from *Phyllachora.* It is not quite clear whether our *Phaeoseptoria* is associated with the tar-spot lesions or is the cause of them. As mentioned, the pycnidia lie just outside of the tar-spot lesions. This variety appears to be more parasitic than the species proper.

Phaeoseptoria Festucae var. *Muhlenbergiae* is readily distinguished from *Septoria mississippiensis* Spr. by its multiseptate

spores but is less clearly distinct from the *S. Bromi* var. *Alopecuri* complex (**2, 8, 9, 10**). The spores of the *Phaeoseptoria* are considerably stouter, however.

Phaeoseptoria Urvilleana (Speg.) comb. nov.

Among material very kindly finished to us by Juan Lindquist, Inst. Spegazzini, was a specimen of *Septoria Urvilleana* Speg. (**7**, p. 387), which now on aging has brown spores, clavulate-filiform, 20–90 × 4.5–6 μ. This fungus, on *Panicum Urvilleanum* from Argentina was described originally as having hyaline to faintly sub-chlorinous spores, but now appears to belong in Spegazzini's genus *Phaeoseptoria* to which we transfer it, as above recorded. This fungus differs from *P. Festucae* in having wider spores, but is more readily distinguished by the less stiff, more gracefully curved spores with only 5- to 7-septa.

The following key will aid in segregating the collections of *Phaeoseptoria* discussed in this article:

A. Spores filiform-bacillar.....................*Phaeoseptoria Elymi* Spr.
AA. Spores clavulate-filiform
    B. Spores yellow to light brown
        C. Spores 60–75 × 2.5–3 μ..............*P. Airae* (Grove) Spr.
        CC. Spores wider, 55–64 × 3.7–4.5 μ.....*P. Festucae* var.
                                          Muhlenbergiae Spr.
    BB. Spores light brown, coarser
        C. Spores 5- to 7-septate, 20–90 × 4.5–
           6.0 μ.............................*P. Urvilleana*
                                   (Speg.) Spr.
        CC. Spores 8- to 13-septate, narrower
            D. Spores vermiform, obtuse, 55–
               71 × 4.3–5.0 μ................*P. Calamagrostidis* Spr.
           DD. Spores obclavate-filiform, scarcely
               vermiform, acute at one end
               or at least acuminate
               E. Spores stiffly obclavate-fili-
                   form, apices acute, bases
                   truncated, scarcely con-
                   stricted at septa, pycno-
                   phores elongate.........*P. Festucae* Spr.
               EE. Spores similar to above but
                   somewhat constricted at
                   septa, pycnophores broad-
                   ened or obscure..........*P. Phalaridis* (Trail)
                                            Spr.

The aid of A. G. Johnson and Edith Cash in the final preparation of the manuscript is gratefully acknowledged.

LITERATURE CITED

1. **Grove, W. B.** British stem- and leaf-fungi (Coelomycetes) Sphaeropsidales. 1, 488 pp. *illus.*, Cambridge. 1935.
2. **Karsten, P. A.** Symbolae ad mycologiam fennicam XVI. Medd. Soc. Faun. Fl. Fenn. **11**: 148–161. 1884.
3. **Miyake, I.** [Studies of fungi on rice in Japan.] Bot. Mag. (Tokio) **23**: 85–97; 127–145. 1909. (In Japanese.)
4. ——. Studien über die Pilze der Reispflanze in Japan. Jour. Coll. Agric. Imp. Univ. Tokio 2: 237–276. 1910.
5. **Saccardo, P. A. & Trotter, A.** Sylloge Fungorum **22**: 1121. 1913.
6. **Spegazzini, Carlos.** Fungi Aliquot Paulistani. Rev. Mus. La Plata **15**: 7–48. 1908.
7. ——. Mycetes Argentinensis V. Anal. Mus. Nac. Buenos Aires II. **13**: 329–467. 1911.
8. **Sprague, R.** *Septoria* diseases of Gramineae in the western United States. (In ms.)
9. ——. The status of *Septoria Alopecuri* (Karst.) P. Sydow and some related species. Mycologia **35**: (in press).
10. **Sydow, P.** Beiträge zur kenntniss der Pilzflora der Mark Brandenburg II. Hedwegia (Beiblatt) **38**: 134–140. 1899.
11. **Tehon, L. R. & Daniels, E.** Notes on the parasitic fungi of Illinois II. Mycologia **17**: 240–249. 1925.
12. **Trail, J. W. H.** Revision of Scotch Sphaeropsideae and Melanconieae. Scot. Nat. (N.S. v. 3) **9**: 219–236. 1888.

PHOTOGRAPHS AND DESCRIPTIONS OF CUP–FUNGI—XXXVIII. THE GENUS KRIEGERIA [1]

Fred J. Seaver

In 1878 Rabenhorst (Hedwigia 17: 32) established the genus *Kriegeria* founding it on his own species *Ombrophila ? Kriegeriana* (Rab. Fungi Eur. *2315.* 1878), but suggested changing the specific name to *olivacea* which change was unnecessary and, in fact, unwarranted under the rules. The species on which the genus was founded seems to be quite common in Europe, judging from the number of specimens in our collection. The plants occur on *Abies pectinata* and are characterized by their olivaceous color.

In 1931 the writer established the genus *Chloroscypha* on *Helotium Seaveri* Rehm, a species which occurs on foilage of *Thuja plicata*. This species is also characterized by the peculiar olive green color of the apothecia, which is more apparent when the apothecia are crushed. Both species are further characterized by the comparatively large fusoid to fusiform spores. The writer is convinced that the two genera are identical.

Dr. W. Lawrence White treats *Kriegeria* as a synonym of his genus *Rutstroemia,* but the writer believes that the plants which have been placed in *Kriegeria* and *Chloroscypha* should be retained in a separate genus under the earlier name *Kriegeria.* All the species referred to the two genera occur on foilage, twigs or branches of coniferous trees.

The writer, therefore, proposes that the genus *Kriegeria* be revived and made to include those forms placed by the writer in the genus *Chloroscypha.* The genus then would be as follows:

KRIEGERIA Rab. Hedwigia 17: 32. 1878.·

Chloroscypha Seaver, Mycologia 23: 248. 1931.

For the characters of the genus see MYCOLOGIA reference above.

[1] For illustrations see previous papers on *Chloroscypha* (Mycologia 23: *pl. 23, 24;* 30.: 595, *f. 1.*).

1. Kriegeria Kriegeriana (Rab.) comb. nov.
Ombrophila Kriegeriana Rab. Fungi Eu. *2315.*   1878.
Kriegeria olivacea Hedgwigia **17** : 32.   1878.
Ciboria Kriegeriana Rehm, Hedwigia **22** : 36.   1883.
Chlorosplenium Kriegerianum Sacc. Syll. Fung. **8** : 318.   1889.

2. Kriegeria Seaveri (Rehm) comb. nov.
? *Peziza enterochroma* Peck, Ann. Rep. N. Y. State Mus. **32** : 47.
1879.
? *Ombrophila enterochroma* Sacc. Syll. Fung. **8** : 619.   1889.
Chloroscypha Seaveri Mycologia **23** : 249.   1931.

3. Kriegeria Jacksonii (Seaver) comb. nov.
Chloroscypha Jacksonii Seaver, Mycologia **23** : 249.   1931.
   Note: *Helotium limonicolor* Bres. Fungi Trid. *81.*   1898 re-
sembles this species, except in color which is lemon yellow.   It
occurs on *Thuja orientalis* and doubtless belongs to this genus and
may even be identical with the above.   Without material it is im-
possible to decide.

4. Kriegeria chloromela (Phill. & Plow.) comb. nov.
Peziza chloromela Phill. & Hark. Grevillea **13** : 22.   1884.
Chlorosplenium chloromelum Sacc. Syll. Fung. **8** : 319.   1889.
Chloroscypha chloromela Seaver, Mycologia **23** : 250.   1931.

5. Kriegeria juniperina (Ellis) comb. nov.
Dermatea juniperina Ellis, Am. Nat. **17** : 192.   1883.
Chloroscypha juniperina Seaver, Mycologia **23** : 180.   1931.

6. Kriegeria cedrina (Cooke) comb. nov.
Peziza cedrina Cooke, Buffalo Soc. Nat. Sci. **2** : 294.   1875.
Lachnella cedrina Sacc. Syll. Fung. **8** : 395.   1889.
Chloroscypha cedrina Seaver, Mycologia **30** : 594.   1938.

NEW YORK BOTANICAL GARDEN

MYCOLOGIA

NEW SPECIES OF SPHAEROPSIDALES AND MELANCONIALES [1]

David H. Linder

(WITH 1 FIGURE)

Among specimens that have been sent to the writer for determination, there were a few members of the Sphaeropsidales and Melanconiales that could not be matched with the descriptions of species that have appeared in the literature. It is unfortunate, but nevertheless true, that these two orders of the Fungi Imperfecti are taxonomically in a most unsatisfactory state. One of: the factors bringing about this condition is the all too prevalent idea that because a fungus occurs on a new host, or even a new organ of the host, it must be considered a new species despite morphological similarities. It is clear that this method of classifying parasitic fungi is extremely simple, but at the same time equally superficial. It does not contribute to a stable nomenclature nor does it add to our knowledge of the biology of the forms, facts that are needed if we are to apply our information to the efficient control of diseases. Another source of difficulty in satisfactorily reaching a decision as to the identity of the fungi in these two orders is the number of genera which have been segregated on unstable and intergrading characters, characters which may have had some standing when only a few species or specimens were known but which, with the advance of knowledge, appear to have lost their sig-

nificance. Since many of the genera have been maintained, each of them must be taken into consideration if synonymy be not increased beyond all hope. Recognizing the aforementioned difficulties, the writer has hesitated to add to them by describing the following species as new even though considerable care and time has been expended in order to avoid adding to the list of synonyms that must exist. The species about to be described appear sufficiently distinct from others in the genera in which they have been placed or from other species in related genera to warrant their recognition. The first two species from Brazil were communicated by Professor H. H. Whetzel of Cornell University (CU) ; the last three species, all on live blister rust cankers of *Pinus monticola* Dougl., were sent by Dr. John Ehrlich of the School of Forestry, University of Idaho, Moscow, Idaho (UIFP). To both his colleagues, the writer wishes to express his appreciation for the privilege of studying the specimens.

1. Clypeoseptoria Sparothospermi Linder, sp. nov. (FIGS. A–B)

Maculae nigrae, extensae; pycnidiis intra folium formatis, 214–231 μ altitudine, 165–215 μ latitudine, irregulariter late ampulliformis, nonnihil sublobatis, parietibus inaequalibus crassitudinis, interdum invaginatis, plectenchymatis, hyalinis subhyalinisve praeter sub clypeo circum ostiolum nigrescentibus; clypeo hypharum nigrarum in cellulis cuticulae composito; conidiophoris usque ad 35 μ longitudine, ramosis, hyalinis;·conidiis (16)–18–26.5 × 1–1.5 μ, hyalinis, acicularis, curvatis vel nonnihil sinuosis, ad apicem attenuatis.

Spots extensive, black, orbicular or irregular. **Pycnidia** 214–231 μ high, 165–214 μ wide, imbedded in the host tissue, irregularly and broadly flask-shaped or somewhat lobate, the walls of uneven thickness, tending to be invaginated, plectenchymatous, hyaline or subhyaline except around the ostiole where the tissue under the clypeus, which extends into the epidermal cells of the host and blackens them, becomes darkened. **Conidiophores** up to 35 μ long, mostly branched, hyaline, lining the greater part of the pycnidial cavity. **Conidia** (16)–18–26.5 × 1–1.5 μ, hyaline, acicular, curved or somewhat sinuate, tapering towards the pointed apex.

Brazil: Divinopolis, Minas Gerais, on *Sparothospermum* sp. (Bignoniaceae), Feb. 15, 1940, *O. Drummond, 1363,* **type** (CU, FH).

The hyaline or subhyaline pycnidial walls and the formation of the clypeus seem to furnish good characters for the segregation of the genus, while the morphological characters separate this from the original species. This represents the first collection from South America.

2. Phyllosticta brasiliensis Linder, sp. nov. (FIGS. C–E)

Pycnidiis in foliis emortuis, globosis, nigris, immersis vel erumpentibus, 155–206 µ diametro, parietibus pseudoparenchymatis, ostiolo in speciminibus juvenibus modo areae orbicularis cellularum magnarum nigrarum compositae, in speciminibus maturis modo foraminis cellulis bis ad quater ampliis quam cellulae aliae pycnidii uniseriate cincti; conidiophoris brevibus, simplicibus, usque ad 11.5 µ longitudine, ad basem 2.5–3.5 µ diametro, sursum attenuatis, ex cellulis globosis vel subglobosis intra pycnidium oriundis; conidiis hyalinis, ovoideis, ellipsoideis vel crepiduliformibus, 11.5–12.5 × 6.5–7.5 µ.

Pycnidia formed in the dead leaves of the host, black, globose, immersed or erumpent, 155–206 µ diam., the wall black, pseudoparenchymatous; the ostiole in young specimens present as a circular area of large cells (2–4 times the size of the remaining cells), in older specimens as a pore bordered by a single row of large cells. **Conidiophores** lining the cavity of the pycnidium, simple, short, up to 11.5 µ long, 2.5–3.5 µ in diameter at the base, tapering to the slender apex, arising directly from globose or subglobose colored cells lining the pycnidial cavity. **Conidia** hyaline, ovoid, ellipsoid, or slipper-shaped, 11.5–12.5 × 6.5–7.5 µ.

Brazil: Minas Gerais, causing serious damage to seedlings of *Araucaria brasiliana,* Jan. 15, 1941, *O. Drummond, 1391,* **type** (CU, FH).

This species is distinguished from both *P. Araucariae* and *P. araucariaecolor* by the shape and large size of the conidia. In view of the woody nature of the leaves of the host, there is no reason why this species should not be placed in *Phoma* or *Macrophoma,* especially since it is more than likely that the fungus may also fruit in the twigs or young stems. Precedence, however, seems to decree that the species be placed in *Phyllosticta.*

3. Dothiorella pinastri Linder, sp. nov. (FIGS. F–G)

Pycnidia sparsa, subglobosa, rugulosa, nigra, immersa vel mox erumpentia, usque ad 1 mm. diametro, pluriloculata; loculis irregulariter formatis et in stromate compacto et pallide colorato praeter cellulas exteriori quas nigras;
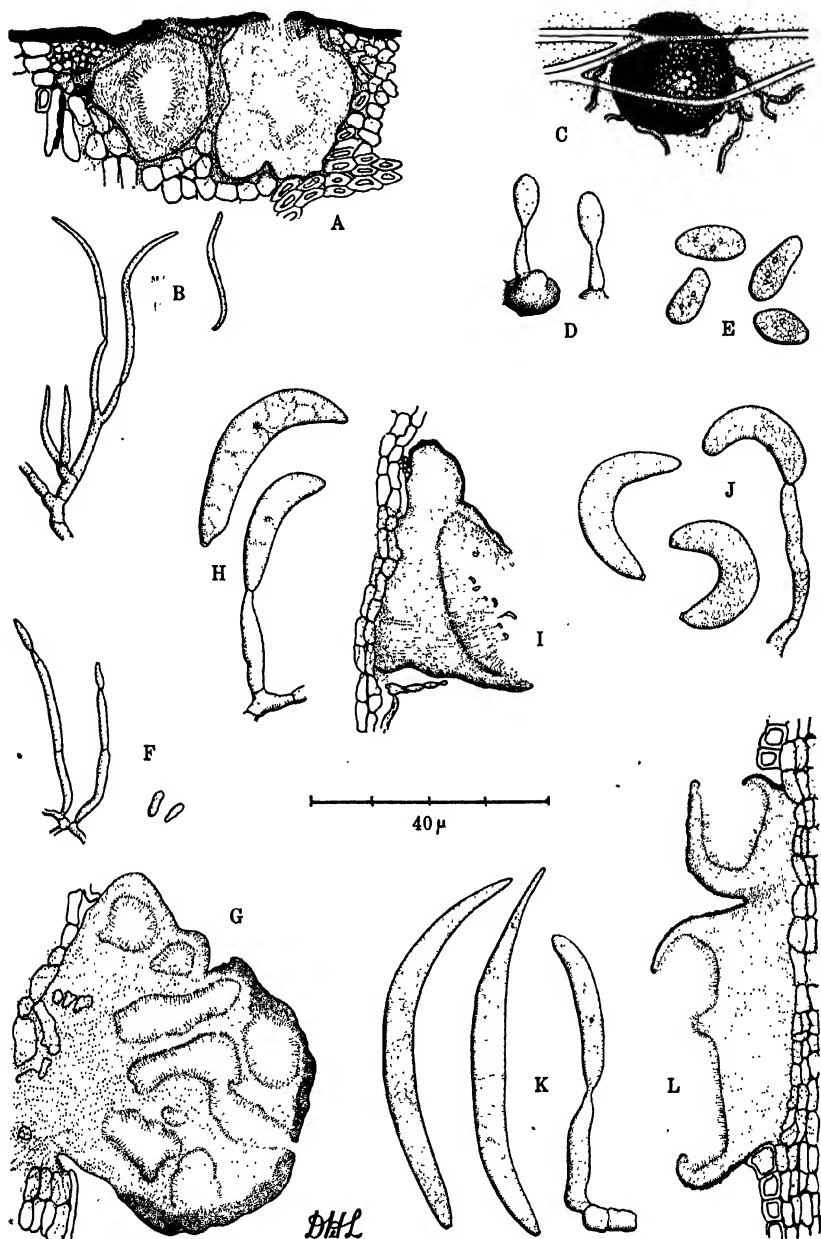
Fig. 1. *A,' B, Clypeoseptoria Sparothospermi; C–E, Phyllosticta brasi-liensis; F, G, Dothiorella pinastri; H, Cryptosporium candidum; I, J, Crypto-sporium lunasporum; K, L, Cryptosporium pinicola.*

conidiophoris hyalinis, septatis, simplicibus vel rare ramosis, usque ad 30 μ longitudine, 1–1.5 μ diametro, intus ad superficiem locularum oriundis; conidiis elongato-ellipsoideis vel interdum ad apicem acutis, hyalinis, 3–4 × 0.5–1 μ.

Pycnidia scattered, subglobose, rugulose, black, immersed or soon erumpent and becoming superficial, up to 1 mm. in diameter, plurilocular; loculi of irregular shape and in a stroma of light colored to brownish compact tissue which becomes dark brown or ·black at the surface. **Conidiophores** hyaline, septate, simple or rarely branched, up to 42 μ long, 1–1.5 μ in diameter, borne on the inner surfaces of the loculi. **Conidia** acro-pleurogenous, elongate-ellipsoid or occasionally somewhat pointed at one end, hyaline, 3–4 × 0.5–1 μ.

Idaho: Bonner Co., Big Creek, Kaniksu National Forest, on live blister rust cankered branch of *Pinus monticola* Dougl., July 8, 1941, *R. T. Bingham, 208* & *R. C. Stillinger,* **type** (FH, UIFP–2821).

4. **Cryptosporium pinicola** Linder, sp. nov. (FIGS. K–L)

Acervulis erumpentibus, primum globosis et loculatis, nigris, demum rumpentibus et cupuliformibus vel disciformibus, 175–500 μ diametro, cum cuticula hospitis circumdatis; stromate prosenchymato vel cellularum cubicarum vel rectangulatarum, cellulis prope centrum dilute fuscis, prope marginem fuscis; conidiophoris usque ad 44 μ longitudine, 2–3.5 μ diametro, hyalinis vel subhyalinis, simplicibus ramosisve, hymenium aequale vel plicatum formantibus; conidiis (26.5)–33–36–(45) × 3.3–(5.7) μ, acrogenis, hyalinis vel subhyalinis, falcatis, nonnihil abrupte ad basem angustam truncatam fastigatis et ad apicem tenuem attenuatis.

Acervuli erumpent, at first globose and loculate, black, later rupturing and becoming more or less cup- or disc-shaped, 175–500 μ in diameter, bordered by the broken epidermis of the host, the stroma of dilute fuscous or rectangular cells or, at the margin, prosenchymatous and dark brownish. **Conidiophores** up to 44 μ long, 2–3.5 in diameter, hyaline or subhyaline, simple or branched, forming a loose, even or folded hymenium. **Conidia** acrogenous, (26.5)–33–36–(45) × 3.3–(5.7) μ, hyaline or subhyaline, falcate, rather abruptly tapering to a narrow, truncate base, the apical end attenuate and slender.

Idaho: Shoshone Co., St. Joe National Forest, on live blister rust cankers on *Pinus monticola* Dougl., Dec. 15, 1940, *R. T. Bingham, 98a* (FH, UIFP–3015); Shoshone Co., Steamboat Creek,

Coeur d'Alene National Forest, on living blister rust cankers of *P. monticola* Dougl., May 22, 1940, *R. L. MacLeod,* type (FH, UIFP–2819).

C. pinicola is intermediate between *C. Boycei* Dearn. and *C. candidum* Dearn. (FIG. H). From the former it may be distinguished by the somewhat smaller size of the spores, and from the latter by the fact that the conidia are larger and acuminate rather than strongly tapering to a relatively sharp point.

5. Cryptosporium lunasporum Linder, sp. nov. (FIGS. I–J)

Acervulis erumpentibus, primum globosis loculatisque, nigris dein rumpentibus et cupuliformibus vel disciformibus, circa 350 μ diametro; stromate cum margine sterili prosenchymato, intus sub hymenio cellularum parallelarum elongato-rectangulatarum, dilute fuscarum; conidiophoris hyalinis plerumque non ramosis, saepe non septatis, usque 30 μ longitudine, 2–2.5 μ diametro; conidiis 16.5–21.5 × 5–6 μ, acrogenis, hyalinis vel subhyalinis, falcatis, ad apicem et basem abrupte rotundatis.

Acervuli erumpent, at first globose, black or dark brown, then breaking open and becoming shallow cup-shaped, about 350 μ in diameter. **Stroma** with sterile margin of prosenchymatous tissue, under the hymenium composed of parallel elongate rectangular cells which are at right angles to the subhymenium, the sterile margin more or less deeply colored, deeper colored than the stroma under the hymenium. **Conidiophores** hyaline, mostly simple and unbranched, up to 30μ long, 2–2.5 μ in diameter. **Conidia** 16.5–21.5 × 5–6 μ, acrogenous, hyaline or subhyaline, falcate, abruptly rounded at both ends.

Idaho: Kootenai Co., at 4000 ft. elev. on Cabin Creek, on live blister rust canker of *Pinus monticola* Dougl., Nov. 16, 1940, *R. T. Bingham, 83B,* type (FH, UIFP–3367).

This species is characterized by the smaller spores with rounded ends. The differences between the species that occur on conifers in North America can best be brought out by the following key to the species:

A. On twigs and bark.
  B. Conidia acuminate-acute.
      C. Conidia 3-septate, 45–75 × 3.5–5 μ, on *Pseudo-tsuga.*   C. Boycei
      C. Conidia non-septate, (26.5)–33–36–(44.5) × 3.3–(5.7) μ, on *Pinus.*   C. pinicola

B. Conidia with acute or rounded apices, not acu-
   minate.
   D. Conidia abruptly rounded at the ends, 16.5–21.5
      × 5–5.5 μ, on *Pinus*.   C. lunasporum
   D. Conidia sharply tapering to very slender
      rounded ends, 23–31.5 × 5–6.6 μ, on *Abies*.   C. candidum
A. On needles; conidia subhyaline to brownish, 0–1–3-
   septate, 19–32 × 3.5–4.5 μ, on *Pinus*.   C. acicolum

The genus *Cryptosporium* is one that offers difficulty in defini-
tion. In the early stages of development certain of the species, as
among those listed in the key above, might well be placed in the
Sphaeropsidales because of the formation of pycnidia which, how-
ever, later rupture to form acervuli with free margins. Such
acervuli with free and often sterile margins are also characteristic
of the Excipulaceae and yet the genus is placed in the Melanconia-
ceae. Within the latter family are the genera *Hainesia, Gloeo-
sporium,* and *Cryptosporium* between which there appears to be no
sharp line of demarcation. Thus *C. acicolum,* since it occurs on
leaves, might well be placed in *Hainesia* or even in *Cercospora.*
Of the other conifer inhabiting species, *C. lunasporum* approaches
the large-spored species of *Gloeosporium* and *Discula,* but because
of the free margin of the acervulis, appears to be closer to the
latter genus. If *C. acicolum* be excluded, the essential characters
of *Cryptosporium* appear to be the large, falcate conidia, the erum-
pent acervuli which are at first pycnidium-like but later rupture
and become shallow-cupulate or discoid, and the predominant oc-
currence of the fungi on bark and twigs.

FARLOW HERBARIUM,
   HARVARD UNIVERSITY

EXPLANATION OF FIGURES

Clypeoseptoria Sparothospermi. **A**: Semidiagrammatic drawing to show
pycnidia imbedded in the host leaf and under the clypeus. **B**: Conidio-
phores and conidia.

Phyllosticta brasiliensis. **C**: Pycnidium imbedded in host tissue as seen
from above. Note large cells around ostiole. **D**: Conidiophores and
young conidia. **E**: A group of conidia showing variation in size and
shape.   ❦

Dothiorella pinastri. **F**: Conidiophore and conidia. **G**: Section of pyc-
nidial stroma showing irregular size and distribution of loculi, and the
darker outer portion of the stroma.

Cryptosporium candidum Dearn. **H**: Conidiophore and conidia.

Cryptosporium lunasporum. **I**: Semidiagrammatic section of acervulus. **J**: Conidia and conidiophore.

Cryptosporium pinicola. **K**: Conidia and conidiophore. **L**: Semidiagrammatic section of acervuli, the upper acervulus showing evidence of the former pycnidial structure.

(Figures A, C, G, I, and L shown at a magnification of approximately × 50; the remaining figures at a magnification of × 800, as represented by the 40 μ scale.)

THE PERFECT STAGE OF CERCOSPORA SORDIDA

FREDERICK A. WOLF

(WITH 1 FIGURE)

Throughout the southeastern United States the foliage of trumpet creeper, *Tecoma radicans* (L.) Juss., is commonly attacked by the imperfect fungus *Cercospora sordida* Sacc. This organism was first known to mycologists about 1880, from collections made in Georgia by H. W. Ravenel, who sent specimens to P. A. Saccardo for identification. He, in turn, described it in Michelia, in 1880, and illustrated it the following year in Fungi italici. Subsequently this fungus is listed from collections in New Jersey by J. B. Ellis (Ellis and Everhart, 1885), in Alabama, by G. F. Atkinson (1891), and in Texas, by F. D. Heald and F. A. Wolf (1912), and is among their exsiccati. These facts and other pertinent information on *Cercospora* are contained in the comprehensive accounts of Solheim (1929) and Lieneman (1929).

The present studies, extending over a period of years, are herein recorded as a part of series of observations by the writer on the life history and development of imperfect fungi having perithecial stages that are initiated by spermatia and ascogonia. Some of these observations, involving species of *Cercosporella, Lecanosticta, Marssonia, Polythrincium, Ramularia, Septocylindrium, Septoria,* and *Cercospora,* have already been published, but a considerable number of others, as yet unpublished, clearly establish that spermatia and ascogonia are precursors of the ascogenous stage.

CONIDIAL STAGE.

Cercospora sordida occurs most abundantly during late summer on leaves nearest the ground. It may be manifest as an effuse, olive-brown coating over essentially the entire lower leaf-surface or may appear in irregular patches. If viewed from the upper

surface, infected leaves show indefinite, vein-limited, yellowish-green areas.   Premature defoliation ensues.

As appears to be the case with other effuse species of *Cercospora*, some conidiophore fascicles emerge from the stomata and others arise as lateral branches of the external mycelium.   Those of the former kind are non-stromatic at first (FIG. 1 *D*), but toward the end of the season small stromata, situated in the substomatal cavities, develop in the base of the conidiophore fascicle.   The conidia vary in shape from oblong-cylindrical to narrowly obclavate, the younger tending to be cylindrical and the older to be narrow apically (FIG. 1 *C*).   They are dilute brown and range in size from 20–180 × 3–4.5 μ.   Few to many septa are formed and oil droplets are abundant.

SPERMATIAL AND ASCOGONIAL STROMATA.

Spermatia and ascogonia form coincidentally in separate stromata.   The primordia from which they arise are quite alike at first, appearing as dark pin-point structures densely aggregated.   They are amphigenous but are most abundant however at the lower leaf surface.   They are formed, beginning shortly after the leaves have fallen, and continue to develop throughout the entire autumn.

Vertical sections of diseased leaves, if stained with Haedenhain's haemotoxylin, show that the dark stromatic structures are of two types, spermogonial and carpogonial.   Very commonly each stroma can be seen to have arisen by proliferative development within the basal part of the conidiophore fascicle (FIG. 1 *A*).   Each, in turn, consists of a peripheral layer of thick-walled cells that surround a medullary portion which stains deeply.   In spermogonia the medullary cells are arranged in rows whereas in carpogonia they are entirely inordinate.

The sequence of changes during formation of spermatia is indicated to be as follows.   Each of the series of medullary cells is a spermatium-mother cell.   Spermatia appear to arise as buds from the mother cells after which the walls of the exhausted cells disintegrate to form a mucilaginous matrix.   Spermatial formation begins near the spermogonial orifice and proceeds basipetally.   When this process is only partly complete the spermogonium may

appear multilocular whereas it really is unilocular. This appearance results because spermatial formation does not proceed at the same rate with all chains of spermatiferous cells. Eventually when all the spermatium-mother cells are exhausted, the locule is filled with bacilliform spermatia, $2 \times 1 \mu$, that are embedded in a mucilaginous matrix. If moisture is present this matrix swells and causes the spermatia to exude from the orifice.

While these developments are taking place within the spermagonia one to three ascogones are being formed in each of the near-by carpogonial locules. The course of their development appears to be like that noted (Wolf and Davidson, 1941) for *Mycosphaerella effigurata* (Schw.) House. Each ascogone is filamentous and consists of a few enlarged basal cells and a trichogynal portion that projects from the apex of the stroma. Evidence that the trichogynes serve as receptive surfaces for the spermatia, as an essential structure in fertilization, rests upon reaction in the presence of water. If leaves are kept free from water-films perithecia do not develop, whereas if they are wetted, the carpogonia in due time become transformed into perithecia.

PERITHECIAL STAGE.

By late March or early April of the succeeding year the perithecial stage will have matured within decaying leaves left lying on the ground. Perithecia, although most abundant at the lower leaf surface, occur on both surfaces. They range in diameter from 60 to 90 μ. If perithecia are crushed under the cover glass the asci are observed to adhere in a group. Each ascus is cylindrically saccate and measures 36 to 45 by 8 to 10 μ (FIG. 1 *B*). Paraphyses are wanting. The ascospores tend to be biseriately arranged, and are almost hyaline. At discharge they are unequally two-celled, the upper cell being somewhat the broader.

ISOLATION IN CULTURE.

To isolate the pathogen in pure culture a suspension of conidia was streaked on poured plates of potato agar. Growth had progressed, within 48 hours, to the extent that colonies were visible to the unaided eye. After an additional day's growth conidia charac-

teristic of the species were being produced by these young colonies. Production of conidia by *Cercospora* in newly isolated cultures has been observed by various investigators including Nagel (1934), Latham (1934) and Diachun and Valleau (1941). Nagel employed *Cercospora althaeina* Sacc., *C. avicularis* Wint., *C. beticola* Sacc., *C. cruenta* Sacc., *C. Davisii* Ellis & Ev., *C. dubia* (Riess.) Wint., *C. Muhlenbergiae* Atk., *C. moricola* Cooke, *C. mirabilis* Sharp, *C. Medicaginis* Ellis & Ev., *C. Physalidis* Ellis, *C. Setariae* Atk., and *C. zebrina* Pass. The study by Latham involved *Mycosphaerella cruenta* (Sacc.) Latham, having *C. cruenta* as its conidial stage, and that by Diachun and Valleau, *Cercospora Nicotianae* Ellis & Ev.

After a few weeks the colonies of *C. sordida* had attained maximum growth. They were then compact, dense, elevated, smoky-gray in color, and were approximately 1 cm. in diameter.

Isolations from ascospores were obtained by placing moistened leaves bearing mature perithecia, immediately below the surface of inverted plates of agar. The ascospores were thereby permitted to be forcibly discharged onto the agar. Here the ascospores germinated by the simultaneous formation of a tube from the tip of each cell or from one cell only. After 72 hours conidia like those of *C. sordida* were borne on the developing colonies. In time, these colonies that originated from ascospores were indistinguishable from those originating from conidia and, like them, soon ceased to produce conidia. The causes for failure of old cultures to produce conidia remain unknown but appear to be associated with staling.

IDENTITY OF THE ORGANISM.

The morphologic features of the organism under consideration are clearly those of the genus *Mycosphaerella*, which admittedly includes a large and heterogeneous assemblage of sphaeriaceous species. Since no members of this genus have been reported previously as pathogens on trumpet creeper, and since this study establishes for the first time connection with *Cercospora sordida*, the fungus is regarded as new and is briefly described as follows:

Mycosphaerella Tecomae sp. nov.

Syn. *Cercospora sordida* Sacc. Mich. 2: 149, 1880; Fungi Ital. *pl. 683,* 1881; Syll. Fung. 4: 470, 1886.

Peritheciis dispersis, hypophyllis vel interdum amphigenis, subinnatis vel erumpentibus, atratis, sphaericis, 50–80 μ diam.; ascis cylindracei-sacciformibus, fasciculatis, aparaphysatis, 36–45 × 8–10 μ, ascosporis sub-biseriatis, ellongato-ellipticis, uniseptatis, loculo supero crassiore, vix constrictis, rectis, hyalinis, 9–12 × 3–4 μ.
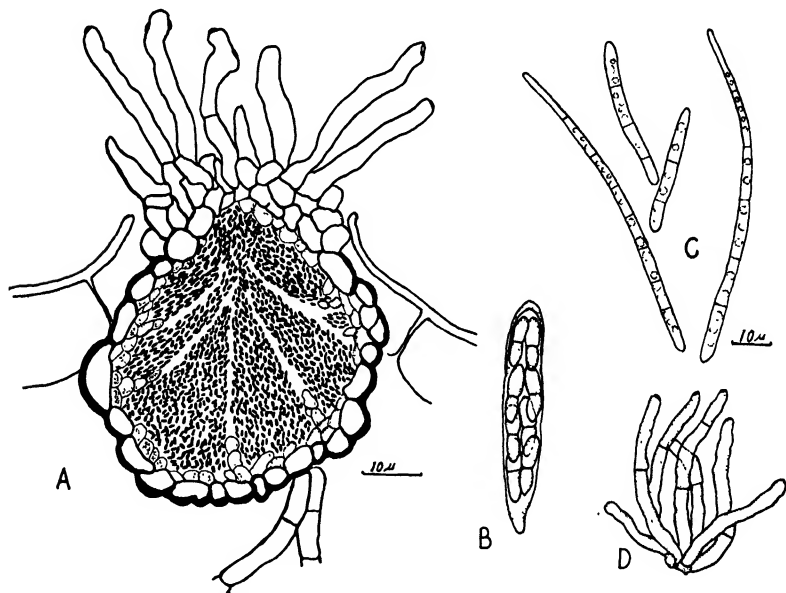
FIG. 1. Structures associated with *Mycosphaerella Tecomae. A,* spermogonium, in section, produced at base of fasicle of conidiophores; *B,* ascus of *M. Tecomae; C,* conidia from *Cercospora sordida; D,* conidiophoral fascicle. *A* and *B* drawn to scale near base of spermogonium, *C* and *D* to scale near them.

Hab. in pagina adversa foliorum putrescentorum Tecomae radicantis, in verno.

Spermagoniis et carpogoniis in autumno efformantibus, amphiginis, innatis, punctiformibus, in loculis stromaticis oriundis, globosis, atris; spermatiis bacillaribus, hyalinis, 2–3 × 1 μ; ascogoniis flexuosis, filiformibus.

Status conidicus: *Cercospora sordida* Sacc. statum conidicum sistit. Maculis superne lutescentibus, indefinitis; caespitulis hypophyllis, effusis, sordide olivaceis, ex stomatibus vel hyphis externis oriundis; hyphis laxe fasciculatis, septatis, rufescentibus; conidiis acrogenis vel pleurogenis, aciculari-obclavatis, 20–180 × 3–45 μ, pluriseptatis, dilute rufescentibus.

Hab. parasitice in paginis *Tecomae radicantis.*

Specimens have been deposited in the Farlow Herbarium, Harvard University, and in the herbarium of the New York Botanical Garden.

DISCUSSION.

The perfect stages are known for less than a dozen of the 516 North American species of *Cercospora* in the host index by Lieneman (1929). All with established connection have been assigned to *Mycosphaerella*. Data are still too meagre however to conclude that many or all species will eventually be found to possess perfect stages of the same type. Moreover in all *Cercospora* species, known to belong to *Mycosphaerella*, it has not been shown that the ascogenous stage is initiated by spermatia and ascogonia but it seems reasonable to assume that such is the case.

Conidiophores and conidia were observed to be produced in abundance by development from the ostiolar region of perithecia of *Mycosphaerella Tecomae*. The condition that favors this development appears to be maintenance of high relative humidity, since it occurred only when leaves were kept enclosed in dishes lined with moistened paper. Production of conidiophores and conidia by proliferative growth from perithecia does not appear to have been recorded for any other *Cercospora*. It is known however in *Mycosphaerella Fragariae* (Tul.) Sacc. which similarly bears *Ramularia Tulasnei* Sacc. (Dudley, 1889), in *Sphaerella Tussilaginis* Rehm, which similarly produces *Ramularia brunnea* Peck (Wolf, 1912), and in a few other species.

SUMMARY.

This study involves the developmental cycle of the imperfect fungus *Cercospora sordida,* long known to infect the foliage of *Tecoma radicans*. As structures, not previously known, this fungus has been found to produce, on fallen leaves, during late summer and autumn, spermogonia and carpogonia, the initials of the perithecial or ascogenous stage. By the following spring the ascogenous stage will have matured within the tissues of decaying leaves.

The perithecial stage is herein briefly described as *Mycosphaerella Tecomae,* and evidence of genetic connection with *Cercospora sordida* is presented. Evidence of connection is as follows: (1) Cultures isolated from conidia are identical in appearance with those isolated from ascospores; (2) *Cercospora* conidia are formed in young cultures, both those isolated from conidia and those isolated from ascospores; (3) *Cercospora* conidiophores and conidia are abundantly produced from the ostiolar region of the perithecia of *M. Tecomae.*

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LITERATURE CITED

Atkinson, G. F. Some Cercosporae from Alabama. Jour. Elisha Mitchell Sci. Soc. **8**: 33–67. 1891.

Diachun, S. & W. D. Valleau. Conidial production in culture by *Cercospora Nicotianae.* Phytopath. **31**: 97–98. 1941.

Dudley, W. R. The strawberry leaf blight, *Sphaerella Fragariae* (Tul.) Sacc. Cornell Agr. Exp. Sta. Bull. **14**: 1889.

Ellis, J. B. & B. M. Everhart. Enumeration of the North American Cercosporae. Jour. Myc. **1**: 17–24, 33–40, 49–56, 61–67. 1885 (Vide p. 53).

Heald, F. D. & F. A. Wolf. Plant disease survey in the vicinity of San Antonio, Texas. U. S. Dept. Agr., Bureau Pl. Ind. Bull. **226**: pp. 129. 1912 (Vide p. 79).

Latham, D. H. Life history of a *Cercospora* leaf spot fungus on cowpea. Mycologia **26**: 516–527. 1934.

Lieneman, Catherine. Host index of the North American species of the genus *Cercospora.* Ann. Mo. Bot. Garden **16**: 1–52, 1929.

Nagel, C. M. Conidial production in species of *Cercospora* in pure culture. Phytopath. **24**: 1101–1110. 1934.

Solheim, W. G. Morphological studies of the genus *Cercospora.* Ill. Biol. Monog. **12**: 7–84. 1929 (Vide pp. 59–60).

Wolf, F. A. The brown leaf spot of colt's foot, *Tussilago farfara* L. Ann. Myc. **10**: 65–67. 1912.

Wolf, F. A. & R. W. Davidson. Life cycle of *Piggotia Fraxini,* causing leaf disease of ash. Mycologia **33**: 526–539. 1941.

ELSINOE VITICOLA

A. A. Bitancourt and Anna E. Jenkins

(with 1 figure)

In connection with his study of the Astérinées, Arnaud (1) made a survey of the Myriangiales as then known. His study of this mostly exotic group was based chiefly on herbarium material. The two species of *Elsinoë* that he examined were *E. Canavaliae* on *Canavalia gladiata* and *E. viticola* on *Vitis coriacea* from Bogor (Buitenzorg), Java. Both these species were described by Raciborski in 1900 (12 [1: 14; 2: 4]) and specimens of each were distributed by him in his *"Cryptogamae parasiticae* in *insula Java lectae exsiccati"*; [1] *E. Canavaliae* appears in Fascicle I, No. 9, and *E. viticola* in Fascicle II, No. 83. Only Raciborski's record of these two species is given in the list of fungi of the Dutch East Indies published in 1922 by the van Overeems (10) ; moreover, the two fungi named are represented only by a small amount of material in the Mycological Herbarium of the "Instituut voor Plantzeikten" at Buitenzorg. This was ascertained by correspondence with S. J. Wellensiek, who wrote also that nothing had been done on the relative fungi of Java since 1900. The herbarium specimens of *E. Canavaliae* and *E. viticola* in Java are here regarded as the actual type material and that distributed elsewhere in *"Cryptogamae parasiticae"* as of the type collection. In the interest of the present study, H. R. A. Müller searched for *Elsinoë viticola* on living Vitaceae in the Botanical Gardens at Buitenborg, but without success. He wrote [2] as follows:

"In answer to your letter of March 11th I beg to inform you that up till now it has not been possible to find any trace of *Elsinoë viticola* Rac. on *Vitis coriacea* or on other Vitaceae in the Buitenzorg Botanical Garden, though the plants have been repeatedly inspected by Dr. Karthaus and myself."

[1] Buitenzorg, 1899.
[2] Letter dated September 26, 1938, addressed to the junior writer.

When Arnaud (1) studied *E. Canavaliae* and *E. viticola,* he was under the impression that they were hyperparasites (Compare 1, p. 675–676 and 685–686), although he later recognized (2) them as the true cause of the characteristic leaf galls with which they were associated.   The specimens of Raciborski that Arnaud studied are in the Paris Museum.   His account of *E. Canavaliae* (1, p. 685–686) is reproduced here almost completely, because it precedes and is more or less preliminary to his study of *E. viticola*.   The careful description of the leaf malformations produced by *E. Canavaliae* is quoted below:

Le Champignon semble provoquer la formation de cloques sur le limbe de la feuille; ces déformations sont convexes du côté inférieur, plus rarement du côté supérieur (fig. A). Le tissu des cloques est plus épais que celui du limbe normal; mais l'augmentation d'epaisseur est surtout due a la formation d'une épaisse couche de liège par une assise génératrice qui doit prendre naissance dans l'épiderme ou dans l'assise sous-jacente; ce liège est du côté convexe; du côté concave on trouve les tissus ordinaires de la feuille peu modifiés, peut-être un peu hypertrophiés. Le liège est formé de deux couches distinctes. Ce tissu est manifestement le résultat d'une réaction de la feuille contre l'attaque d'un parasite primaire dont la nature ne nous est pas connue.[3]

There was only scant production of asci on the material of *E. Canavaliae* examined by Arnaud.   Thus he wrote:

"L'Elsinoe décrit par Raciborski était très maigrement représenté dans l'échantillon examiné, et nous avons eu beaucoup de peine à trouver les asques; ils se trouvent dans la zone externe du liège dans un stroma peu développé, qui s'insinue dans les lacunes du tissu subérifié plus ou moins dissocié et sous l'epiderme également fendillé ([pl. 3] fig. C)."

Arnaud's (1, *pl. 3, A–D*) clear drawings of *Elsinoë Canavaliae,* which is the type species of this recently revised (7) genus, are much prized, as is shown by the citations to them in literature dealing with the group.   Shear (13) has reproduced the detailed drawing (1, *pl. 3, D*), which shows a number of asci in situ in the stroma.   The entire plate, with figure E representing a leaf of *Vitis coriacea* infected by *E. viticola,* is reproduced by Arnaud and Arnaud (2, v. 2, *fig. 630*).

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[3] Lesions of this same character produced on leaves of citrus by *Elsinoë Fawcettii* Bitancourt and Jenkins (Syn. *Sphaceloma Fawcettii* Jenkins) are described by Cunningham (5) and by Butler (4).

With respect to *Elsinoë viticola,* Arnaud (1, p. 686–687) first points out that in the original description, here quoted,[4] the host species is given as *Vitis serrulata* Roxb., while on the printed specimen label it appears as *V. coriacea.* "Dans tous les cas," Arnaud states, "il ne s'agit pas du *Vitis coriacea* Schuttl. des ampélographes qui vient dans la Floride (Amérique du Nord)." The species referred to on the specimen label is doubtless *V. coriacea* (DC.) Miq. In Koorders (9) both these species are listed under the genus *Tetrastigma, V. coriacea* as *T. coriaceum* (DC.) Gagnep. and *V. serrulata* as a synonym of *T. glabratum* (Blume) Planch. In this study the host of *E. viticola* will be referred to as *T. coriaceum.*

The leaf spot on Raciborski's exsiccatum of *E. viticola* is described by Arnaud (1) as follows:

Les feuilles présentent des cloques circulaires saillantes tantôt d'un côte, tantôt de l'autre; d'après Raciborski, elles sont de couleur brun-chocolat et ressemblent à première vue à celles que cause le *Cephaleuros virescens.* Sur les échantillons secs, la face convexe est plutôt grisâtre, la face concave vert brun. La structure est analogue à celle qui a été décrite a propos de l'echantillon précédent; mais les cloques sont moins saillantes; les cellules du liège ont une disposition plus régulière et sont moins déformées. Quand les altérations se trouvent sur une nervure, elles sont allongées et sont simplement formées par un épaississement liégeux, dartreux, sans concavité à la face inférieure.

[4] *Elsinoe viticola* Rac.

An der Unterseite, seltener an der Oberseite der Blätter, ebenso auf den Hauptnerven, wie zwischen denselben bilden sich chocoladebraune, deutlich erhabene, flache Flecke, die unregelmässig rundlich sind, und gewöhnlich mit kleinen Lappen radiär fortwachsen. Die flachen Erhabenheiten, welche den Invasionen des Cephaleuros virescens oberflächlich ähnlich sind, sind Pilzgallen, entstanden durch die Bildung eines mehrschichtigen Lagers, aus korkähnlichen, isodiametrischen, braunwandigen Zellen. Zweischen den Zellen wuchert ein reich septirtes Mycelium, deren kurze Zellen dicht gedrängt sind, und jede der oberflächlichen Zellen, mit einem Pseudoparenchym umgeben. Ziemlich weit von einander bilden sich die Asci, rungliche Sori bildend. Die einzelnen Sori haben 2–16, von einander durch pseudoparenchymatisch verwebte Hyphen getrennte Asci, welche neben und über einander liegen. Die Asci sind rundlich eiförmig, oder ganz rundlich, dickwandig, farblos, 26–28 µ breit, bis 32 µ lang, achtsporig. Die Sporen sind farblos, länglich elliptisch, durch Querwände noch in unreifen Asci in 3–4 Zellen getheilt, neben einander liegend, 15–18 µ lang, 4–4.5 µ dick, farblos.

Bei der Reife verfaulen die pilztragenden Gallen und die Ascosporen treten dann nach aussen.

Auf den Blättern des *Vitis serrulata* Rxb. bei Buitenzorg.
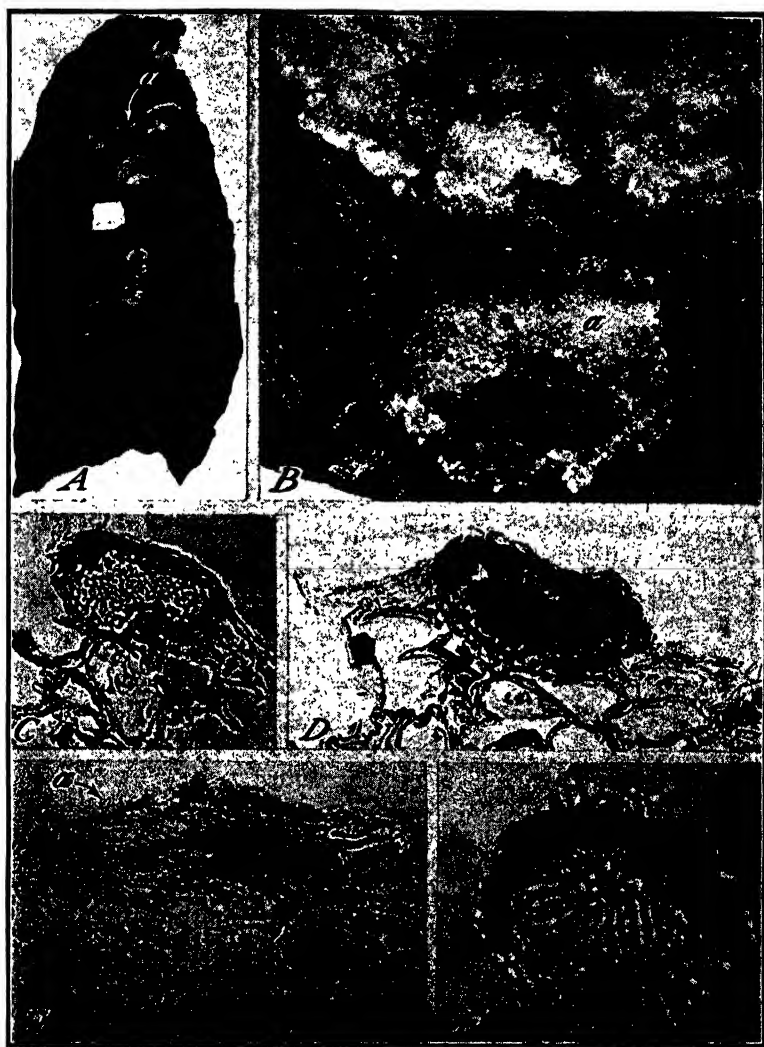
FIG. 1. *Elsinoë viticola* on *Tetrastigma coriacearum* (*Vitis coriacea*), Buitenzorg, Java (Raciborski, Crypt. Par. No. 83). *A*, lower leaf surface showing salient leaf spots XI; *B*, *a*, enlargement of *A*, *a*, × 10; *C* and *D*, sections of two pycnidia of *Phyllosticta* from *B*, possibly representing a secondary organism; *D*, stained with cotton blue, × 500; *E*, section from *A*, *a*, in a region where asci of the *Elsinoë* probably were produced, the diseased leaf tissue here permeated with abundant hyaline hyphae interpreted as of this species × 500; *F*, pycnidia of lichen in vicinity of *B*. Photographs by M. F. L. Foubert (*A* and *B*) and by Bitancourt (*C–F*).

Arnaud's search for asci of *Elsinoë viticola* was unsuccessful. He states:

"Malgré tous nos efforts, nous n'avons pas réussi à retrouver l'Elsinoe de Raciborski sur ces échantillons; nous avons seulement observé sous la cuticule les restes d'un mycélium de Champignon ou d'un thalle d'Algue sans caractères bien déterminés."

The development beneath the cuticle could well have been hyphae of the *Elsinoë*. Arnaud's reference here to an alga may be traced to the discussion in the last paragraph of his account of *E. Canavaliae*.[5]

Critical study of Raciborski's exsiccatum of *Elsinoë viticola* was undertaken in 1938, by the writers, on the basis of Raciborski's exsiccatum of this fungus in the Mycological Collections of the Bureau of Plant Industry, United States Department of Agriculture (FIG. 1, A). The spot chosen for sectioning (FIG. 1, A, a) is shown in figure 1, B, a, at a magnification of 10 diameters. Sections of the most prominent fruiting bodies on the spot, when examined microscopically, proved to be old pycnidia of *Phyllosticta*, not necessarily connected genetically with the *Elsinoë*. The upper part of several of these pycnidia had fallen away; others were intact and are shown in figure 1, C and D. Certain brown, effuse areas on the spot were believed to mark the places where asci of the *Elsinoë* were produced. None were detected, however, in sections of the leaf in these particular regions, but there was an abundance of hyaline hyphae typical of this genus, therefore undoubtedly of *E. viticola* (FIG. 1, D). It is thus still a fact that asci of this species have been viewed only by Raciborski.

A minute green superficial growth near the large spot sectioned was obviously a lichen. One of the two pycnidia present on it is shown in figure 1, F. The spores are 2-celled as illustrated.

[5] This is quoted as follows:
Marshall Ward (*Strigula complanata* (1884), p. 106, Pl. XVIII, fig. 7, 8 et 9; Pl. XIX, fig. 10, 13 et 14) décrit et figure une formation de liège provoquée par le *Strigula* (*Cephaleuros virescens* lichénisé) aux dépens de l'assise sous-épidermique. Dans ce cas, le liège est moins abondant que pour l'*Elsinoe*; mais les feuilles étudiées par Marshall Ward étaient en général coriaces, tandis que les *Elsinoe* ont été signalés sur des feuilles minces où les réactions doivent être plus marquées. Il serait intéressant de rechercher la présence du *Cephaleuros virescens* dans les jeunes cloques des plantes portant les *Elsinoe*. Du reste, pour l'échantillon suivant, Raciborski lui-même indique que les altérations ressemblent à celles du *Cephaleuros*.

The other species of *Elsinoë* known on Vitaceae is *E. ampelina* (DeBary) Shear (13) on *Vitis* spp. including *V. vinifera* L.   In its perfect stage this also is extremely rare, having been found only once.   In its conidial stage, however, it has long been known as *Sphaceloma ampelinum* DeBary or *Gloeosporium ampelophagum* (Pass.) Sacc.   The literature shows that there has been conjecture as to whether this organsim, which causes anthracnose of grape, may not be the same as *E. viticola* (2, v. 1, p. 380, 3, 8, 13) ; in one instance it has been so construed (11, p. 24).   Lesions on *Vitis* produced by *E. ampelina,* illustrated in numerous treatises on plant diseases, are entirely distinct from those on *Tetrastigma* produced by *E. viticola.*   Species of *Elsinoë* are often specific in their host relations and not cross inoculable from one host genus to another even within the same host family.   At any rate, now that the host of *E. viticola* has been shown to be *Tetrastigma* of the Vitaceae and not *Vitis,* the previous reason for considering the grape anthracnose organism as identical or possibly identical with *E. viticola* is eliminated.   *E. viticola* stands without synonomy as originally described.

In the list by the van Overeems, *Elsinoë* appears under the Exoascaceae as it was classified by Raciborski.   An historcial account of the genus including its transfer to the *Elsinoaceae* of the Myriangiales appears elsewhere (6).   Raciborski's description of the genus also has been emended (10).

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LITERATURE CITED

1. **Arnaud, A.**   Les Astérinées IVᵉ partie.   (Études sur la systématique des champignons pyrenomycetes.)   Ann. Sci. Nat. X. 7: 643–722. 1925.
2. **Arnaud, A. & M. Arnaud.**   Traité de patologie végétale.   v. 1 and 2, 1831 p.   Paris.   1931.
3. **Bongini, V.**   Interno ad una infezione di antracnosi della vite.   Lab. Speriment. Regio Osserv. Fitopatol. (Torino.)   Bol. 1: 16–21. 1935.
4. **Butler, E. J.**   Some aspects of the morbid anatomy of plants.   Ann. Appl. Bot. 17: 175–212.   1930.

5. **Cunningham, H. S.** Histology of lesions produced by *Sphaceloma Fawcettii* Jenkins on leaves of citrus. Phytopathology **18:** 539–545. 1928.

6. **Jenkins, A. E.** Scab of *Canavalia* caused by *Elsinoë Canavaliae.* Jour. Agr. Res. **42:** 1–13. 1931.

7. **Jenkins, A. E. & A. A. Bitancourt.** Revised descriptions of *Elsinoë* and *Sphaceloma.* Mycologia **33:** 338–340. 1941.

8. **Jenkins, A. E. & J. G. Horsfall.** A comparison of two species of *Plectodiscella.* Mycologia **21:** 44–51. 1929.

9. **Koorders, S. H.** Exkursionsflora van Java **2:** 558–559. Jena. 1912.

10. **Overeem, (de Haas), V. van & C. van Overeem (de Haas).** Verzeichnis der in Niederländische Ost-Indien bis Jahre 1920 gefunded Myxomycetes, Fungi und Lichenes. Bull. Jard. Bot. Buitenz. III. **40:** 146 pp. 1922.

11. **Puttemans, A.** Alguns dados para servir á historia da phytopathologia no Brasil e ás primeiras motificações de doenças de vegetaes neste paiz. Rodriguésiá **2** (Num. esp.): 17–36. 1936 (1937). Translated in Jour. Agr. Univ. Puerto Rico **29:** 77–107. 1940 (1941).

12. **Raciborski, M.** Parasitische Algen und Pilze Java's. t. 1 (39 pp.) and 2 (46 pp.). Batavia. 1900.

13. **Shear, C. L.** The life history of *Sphaceloma ampelinum* de Bary. Phytopathology **19:** 673–679. 1929.

A NEW SCLEROTINIA CAUSING A DESTRUCTIVE DISEASE OF BULBS AND LEGUMES [1]

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(WITH 11 FIGURES)

In 1931, when the senior author was a graduate student at Cornell University, some tulip bulbs were sent to the Department of Plant Pathology by a florist in Utica, N. Y. These bulbs were completely rotted and densely packed with black sclerotia beneath the tunic and between the scales (FIG. 3). No conidia were present, there was little or no root growth, and in no instance was there any development of the apical shoot. The sclerotia measured up to 6 mm. in diameter and from their appearance it was presumed that the fungus was *Sclerotinia sclerotiorum* (Lib.) de Bary. When isolations were made on potato-2% dextrose agar, it was evident, however, that this was not *S. sclerotiorum,* for it produced much smaller sclerotia, resembling those of *S. minor* Jagger (1920). Cultures of this fungus and of *S. minor* growing on the same medium appeared to be identical. After this initial isolation, no further work was done at that time.

In 1935, a culture of what appeared to be the same fungus was received from Dr. M. W. Cormack of the Dominion Laboratory of Plant Pathology, Edmonton, Alberta. Cormack (1934) had reported this fungus as the cause of a destructive root rot of alfalfa and sweet clover in Alberta. He designated it as *Sclerotinia* sp. on the basis of the appearance of the sclerotia, but he had not seen any apothecia.

A few weeks later, Mr. H. N. Racicot of this laboratory collected some diseased tulips in a garden at Westmount, Que. The disease was confined to one bed of 32 square feet and 70 per cent of the bulbs planted in it had either failed to grow or had devel-

oped a few small leaves with no bloom. The bulbs were packed with sclerotia (FIGS. 1 and 2) and isolations yielded cultures which appeared to be identical with those from the Utica specimens.

Further cultures of the same type were obtained during the next few years. In 1936, a culture was obtained from a collection of completely rotted tulip bulbs sent from a home garden in Montreal, Que. The next year, Cormack sent six more isolates, one from alfalfa, four from white sweet clover, and one from yellow sweet clover. These were followed by another isolate from white sweet clover in 1939. In the same year, the senior author was asked to examine some tulips in a garden in Westmount, Que. This was not the same planting from which the 1935 collection had been obtained. It proved to be of great interest, for not only were the tulips badly infected, but some narcissus bulbs were found similarly attacked (FIG. 4), and isolations yielded the same fungus.

CROSS-INOCULATIONS WITH THE BULB AND LEGUME ISOLATES

Pending the development of apothecia for the identification of these fungi, some experiments were undertaken to determine whether each set of isolates was pathogenic to both tulips and legumes. These trials were made by Dr. M. W. Cormack in plots at Edmonton, Alta.

From the first set of inoculations, made in October, 1936, he reported in April, 1937, that the isolate from the Utica tulips was "highly pathogenic on roots of alfalfa and sweet clover." Later in 1937, we sent him four isolates from tulips, and in June, 1938, he wrote: "All four isolates were highly pathogenic to both alfalfa and sweet clover and in most cases completely rotted the roots and killed the plants. Our isolates of *Sclerotinia* sp. from the legume hosts are consistently more pathogenic to sweet clover than to alfalfa, but your tulip isolates appear to attack these two hosts with equal severity."

In the third trial, tulip bulbs were inoculated, using the Utica tulip isolate in one set and a sweet clover isolate in another. Six varieties of tulips were used representing the Single Early, Cottage, and Darwin types, with four bulbs of each variety for each test. The bulbs were planted on October 8, 1938, in trenches four inches

deep. A small quantity of oat-hull inoculum was placed below and around each bulb at the time of planting. Check bulbs were similarly treated except that sterile oat-hull medium was substituted for the inoculum. The final notes were taken on May 3, 1939, and Cormack summarized these as follows: "The Utica tulip isolate completely rotted all the bulbs of all varieties (FIG. 5), except one bulb of Prince of Austria which was partially rotted and from which weak growth had started. In the case of the sweet clover isolate, similar symptoms were produced (FIG. 6), but there was a greater number of partially rotted bulbs. The uninoculated bulbs were all sound (FIG. 7). With both cultures, the completely rotted bulbs were pulpy in texture and had concentric rings of sclerotia packed between the scales. In the case of the partially rotted bulbs, most of the decay was at the base or between the outer scales and the growth of the shoot was greatly retarded."

These trials clearly indicate that the fungi isolated from the bulbs and from the legumes are vigorously pathogenic not only on their respective original host plants, but also when cross-inoculations are made.

CONDITIONS FOR INFECTION

It is of interest to note the conditions under which infection took place in the experiments at Edmonton. With the inoculum placed around the bulbs and the crowns of the legumes in October, infection was evident the following spring soon after the snow had melted. In contrast to this, during the attempts to obtain apothecia, a number of· flats of soil was inoculated with the various isolates from bulbs and legumes, one isolate to each flat. Small tulip bulbs were planted in these flats, kept in a cold storage room at about 40° F. until the bulbs were rooted, and then ·moved to the greenhouse. A few apothecia developed from some of the isolates, but the tulips grew well and no infection occurred. This fungus, therefore, requires the low temperatures of the soil during the late autumn, winter, and early spring for its pathogenic activity. These requirements are identical with those described for *Sclerotinia convoluta* on garden iris by Drayton (1937). Cormack (1942) refers to the *Sclerotinia* sp. and the other fungi included in his paper as "fungi which attack dormant plants in the early spring."
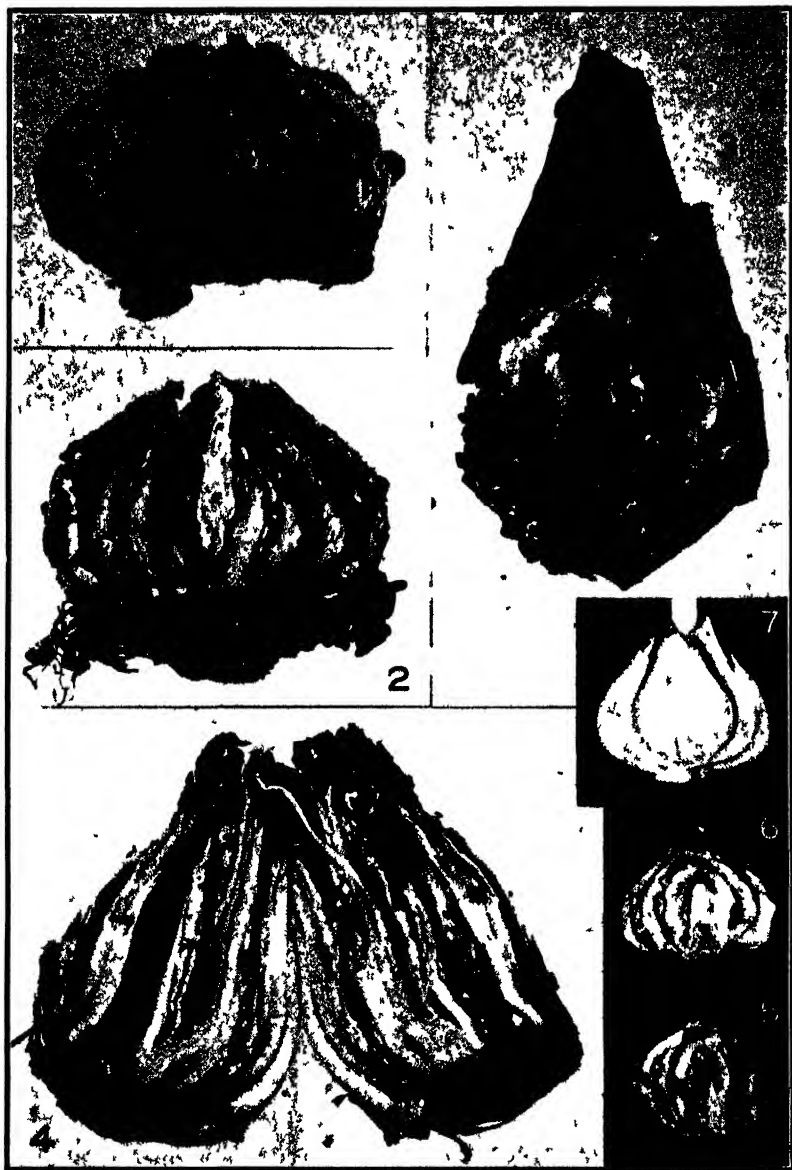
FIGS. 1, 2, tulip bulbs from the Westmount collection showing the decay caused by *Sclerotinia sativa* and the development of sclerotia on the outside and between the scales; 3, affected tulip bulb from the Utica collection; 4, two halves of a narcissus bulb decayed by the same fungus; 5, tulip bulb inoculated with the isolate from Utica tulips; 6, tulip bulb inoculated with a sweet clover isolate; 7, healthy tulip bulb from the uninoculated series.

DEVELOPMENT OF APOTHECIA

The first attempt to obtain apothecia of this fungus was undertaken by the junior author on January 7, 1937, using only the isolates from tulips. The general procedure described by Drayton (1937) and Groves and Drayton (1939) was followed with a few modifications. The Petri dishes with sterilized wheat and water were inoculated and incubated at 14°, 10°, and 5° C. for two months. Half of these cultures were then placed in running water for 48 hours with the idea of leaching out any possible toxic staling products that would normally be removed out of doors by periodic precipitation. Individual sclerotia, as well as pieces of the wheat cultures 3–4 cm. square, were placed on moist sand in preparation dishes. These dishes were put at 0° C. until November, when they were spermatized and moved to 5° C. for one month, then at 10° C. for one month, and finally transferred to the greenhouse at a temperature of about 10–14° C., shaded from direct sunlight. No apothecial fundaments or apothecia appeared in this series.

A second series was begun on April 10, 1937, using isolates from both tulips and legumes. In addition to wheat, rolled oats and corn meal were used as substrata for the vegetative growth. All of the cultures were incubated at 5° C. for two months. As before, individual sclerotia and squares cut from the cultures were placed on moist sand, but without previous leaching, and the preparation dishes were put at 0° C. until November. The cultures were then spermatized and placed at 5° C. for one month, moved to 10° C. for one month, and finally transferred to the greenhouse. Late in February, a few apothecial fundaments appeared on the individual sclerotia from the cultures grown on wheat, but they failed to complete their development and no apothecia were obtained.

A third series was started in November, 1938, using both tulip and legume isolates. These were transferred to wheat plates and for two months half of them were incubated at 14° C. and the other half at 5° C. Only individual sclerotia were used on the sand in the preparation dishes and, as before, they were placed at 0° C., but this time for only one month, and after spermatization put at 5° C. for two weeks, at 14° C. for two weeks, and then

transferred to the greenhouse. The technique used for sperma-
tizing the sclerotia was modified in this series. Instead of applying
the suspension of spermatia in soil extract directly to the sclerotia
with a sterilized camel's hair brush, the suspension was used to
moisten sterilized soil and then the sclerotia were covered with this
soil to a depth of about 3 mm. By June 3, 1939, no fundaments
had appeared and the greenhouse temperature was becoming too
high for further development. The cultures appeared to be in
good condition, however, so they were placed in the 0° C. chamber
until November, when they were returned to the greenhouse. On
March 7, 1940, a mature apothecium was observed and apothecia
continued to develop until early in May (FIGS. 9–11). A number
of single ascospore cultures was obtained from the different isolates.

In this series, one set of sclerotia was left unspermatized and
three sets were spermatized, one with spermatia from a tulip isolate,
one with spermatia from an alfalfa isolate, and the other with a
mixture of spermatia from several isolates. Apothecia appeared
in both spermatized and unspermatized dishes. It was not possi-
ble, however, to conclude from this that the fungus is self-fertile,
because in these preliminary attempts to obtain apothecia, sclerotia
from more than one isolate were put in each dish, in order to
economize space. Under these conditions, it had been found in
another species that even when the isolates are well separated in
each dish, it is possible for spermatia to be washed from one isolate
to another and effect fertilization. It is essential, therefore, in
these forms, that each isolate be kept in a separate dish at all
stages, to obtain accurate information on the sexual reaction.

Before the third culture series was completed, a fourth one was
started in June, 1939, using additional isolates, including the one
from narcissus bulbs and a culture isolated from tulip plants grown
in British Columbia, which we had reason to believe was the true
Sclerotinia minor Jagger. The isolates were grown on wheat as
before, but this time incubated at 0° and 5° C. for three months;
individual sclerotia were placed on sand and held at 0° C. for one
month, they were then spermatized using soil, moved to 5° C. for
one month, then to 14° C. for one month, and finally moved to
the greenhouse on December 26, 1939. On February 15, 1940,
apothecia were mature in all of the cultures of *S. minor* grown

originally at 5° C.   On March 27, two apothecia appeared in one
of the sweet clover isolates, and by April 15 a fair number had
developed from both tulip and narcissus isolates.   The cultures of
S. minor did not grow as well at low temperatures as the bulb-
legume isolates, but even those grown at 5° C. developed apothecia
much more quickly and abundantly than any of the cultures from
bulbs or legumes.   This readiness with which *S. minor* develops
apothecia had been demonstrated previously with authentic cultures
of this species.

A final culture series, designed to determine the sexual behaviour
of this fungus, was begun on May 17, 1940.   Eight single asco-
spore cultures from both tulip and legume isolates were used, and
throughout the experiment they were kept in separate dishes.   The
cultures were grown on wheat at 5° C. and 14° C. for three
months and individual sclerotia were then placed on moist sand
at 0° C. for two months.   One set was left unspermatized, two
sets were spermatized with spermatia from single ascospore cul-
tures from tulip isolates, and two were spermatized with spermatia
from single ascospore cultures from sweet clover isolates.   The
checks were covered with sterilized soil moistened with soil extract
and the others were covered with soil moistened with the spermatial
suspension in soil extract.   After spermatization, the dishes were
put at 5° C. for two weeks, moved to 14° C. for one month, and
finally transferred to the greenhouse on December 21, 1940.

The first apothecia appeared on February 24, 1941, and they
continued to develop until May 15, when the greenhouse was
becoming too warm to continue the experiment.   The cultures ap-
peared to be in good condition however, so they were transferred
to the 0° C. chamber until November, when they were returned to
the greenhouse.   Apothecia began to appear again on February
22, 1942.

Out of the eight single ascospore cultures used in this series,
apothecia were obtained from seven and appeared in both sper-
matized and unspermatized dishes.   This proves conclusively that
this fungus is homothallic and self-fertile.

In his discussion of homothallism, Buller (1941) states that in-
dications point to the fact that *"Sclerotinia* as a genus is hetero-
thallic rather than homothallic."   It has, however, been demon-

strated by Miss Keay (1939) and others that *S. sclerotiorum, S. Trifoliorum,* and *S. minor* are homothallic and self-fertile, and in addition, Godfrey (1923) found this condition in *S. Ricini* through the development of apothecia in undisturbed cultures from single ascospores.

There has been a tendency among authors of recent years to split the genus *Sclerotinia* on the basis of the type of conidial stage, for example, *Monilinia* Honey (1928), with the conidial stage belonging to *Monilia; Septotinia* Whetzel (1937), with a *Septogloeum*-like conidial stage; and *Ovulinia* Weiss (1940), with conidia comparable to those of the form genus *Ovularia.* It seems probable, therefore, that species such as *S. Gladioli* Drayt., in which the apothecia arise from a stroma and not from sclerotia, and the species with conidial stages belonging to the form genus *Botrytis* will eventually be segregated from the group of species closely related to *S. sclerotiorum,* in which the apothecia arise from sclerotia and there is no conidial stage. It is therefore misleading to conclude from *S. Gladioli* and species with conidial stages of the *Botrytis* type that the genus *Sclerotinia,* as at present recognized, is heterothallic. At least in the group typified by *S. sclerotiorum,* to which the tulip-legume fungus belongs, the evidence so far accumulated would indicate that its species are predominantly homothallic.

IDENTITY OF THE FUNGUS

The collection of isolates of this fungus, described earlier in this paper, numbered thirteen. One of these was lost early in the investigation through a sulphur dioxide leak in one of the low temperature chambers. Of the remaining twelve, apothecia were obtained from nine, including four from tulips, one from narcissus, and four from sweet clover. Judging from the morphological characters of the apothecia, the gross appearance of the cultures, the temperature requirements for infection, the high percentage of infection obtained from cross-inoculations, and the conditions required for the development of apothecia, the fungi obtained from the bulbs and from the legumes are identical.

It was noted earlier that this fungus closely resembles *Sclerotinia minor* in the appearance of the cultures. It can, however, be dis-

tinguished from *S. minor* by the darker colour of the apothecia, the smaller asci and ascospores, and by the fact that quite different conditions are required for the production of apothecia.

Another closely related species is *Sclerotinia intermedia* described by Ramsey (1924) on roots of salsify and carrots. In reply to a request for specimens and cultures, Dr. Ramsey sent an
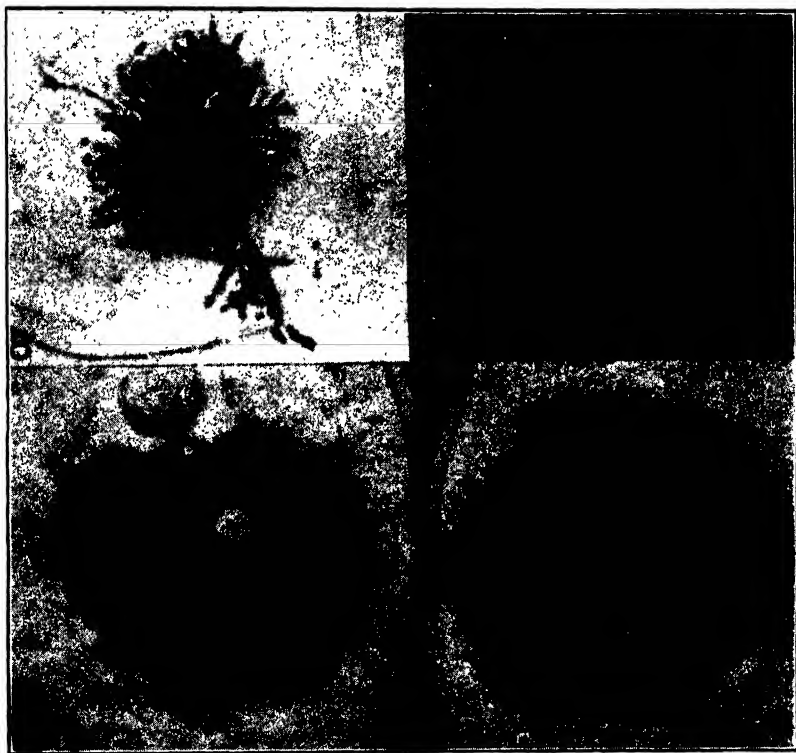
Fig. 8, a young spermodochium of *Sclerotinia sativa* showing the hypha from which it arises and the globose spermatia, × 500; 9-11, apothecia of *S. sativa;* 9, from a sweet clover isolate; 10, from a Westmount tulip isolate; 11, from the Utica tulip isolate.

apothecium embedded in paraffin and a culture with the note that it was one of the original cultures from which the species was described and that it had maintained its individuality and was easily distinguished from *S. sclerotiorum* and *S. minor*. This culture differs markedly from cultures of the tulip-legume fungus in that aerial mycelium is more abundant and sclerotia are fewer and

more fleshy in consistency. The sizes of the asci and ascospores as given in the published description of *S. intermedia* are not very different from those of the tulip-legume fungus, but they do indicate that in *S. intermedia* the asci and ascospores are slightly longer and narrower. This was confirmed on examination of microtome sections of the embedded apothecium sent by Dr. Ramsey. The conditions required for apothecium development appear to differ also, as Ramsey (1925) obtained apothecia of *S. intermedia* from cultures kept at room temperature and, as pointed out above, the tulip-legume fungus must be grown at low temperatures (preferably 0°–5° C.) in order to obtain apothecia. The differences in the asci and ascospores are not great, but together with the differences in the cultures and in the conditions required for apothecium development, it is concluded that the tulip-legume fungus is an undescribed species. As the apothecia of this fungus have been found so far only in cultures, the following name is proposed.

TECHNICAL DESCRIPTION

Sclerotinia sativa sp. nov.

Apotheciis singulis vel pluribus e sclerotiis, stipitatis, cupulatis vel fere planis, demum convexis, 1–5 mm. diam. carnosis "Sayal brown," "cinnamon," "cinnamon buff" vel raro "cinnamon drab," excipulo · concoloro vel obscuriore, pubescento, stipite 2–6 mm. longo, 0.4–0.8 mm. diam. versus basim obscuriore, hypothecio prosenchymato, excipulo pseudoparenchymato; ascis cylindricis, stipitatis, octosporis, 100–120–(130) × (7.5)–8–10 μ; ascosporis ellipsoideis vel ovoideis, hyalinis, continuis, uniseriatis, 9–11–(12) × 4–5–(7) μ, paraphysibus hyalinis, filiformibus, septatis simplicibus vel ramosis, 2.5–3.5 μ diam. apice ad 4–5 μ incrassatis; spermatiis minutis, globosis, uniguttulatis, 2.0–3.5 μ diam.

Hab. in bulbis *Tulipae* et *Narcissi,* in radicibus *Meliloti* et *Medicaginis.*

Sclerotia black, irregular in shape, usually more or less circular to elongated, mostly 1–5 mm. in length, sometimes longer, 1–2 mm. in thickness, frequently becoming laterally fused, and forming irregular crusts, not adhering closely to the substratum; apothecia arising singly or in clusters from sclerotia, 1–5 mm. in diam., disc shallow cup-shaped to almost plane, finally convex, "Sayal brown" to "cinnamon" or "cinnamon buff," occasionally to "cinnamon drab," excipulum concolorous or darker, slightly hairy to almost glabrous, stipe 2–6 mm. long, tapering downward, 0.4–0.8 mm. in diam., dark brown to almost black at the base; hypothecium prosenchymatous composed of ascending, interwoven hyphae about

6–8 μ in diam., excipulum a narrow pseudoparenchymatous zone composed of irregular cells about 7–12 μ in diameter of which the outer cells grow out into short hairs, subhymenium a narrow compact zone of closely interwoven hyphae; asci cylindric with a slender tapering stalk, eight spored, 100–120–(130) $\times$ (7.5)–8–10 μ; ascospores ellipsoid to ovoid, hyaline, one celled, uniseriate, 9–11–(12) $\times$ 4–5–(7) μ; paraphyses hyaline, filiform, septate, simple or branched 2.5–3.5 μ in diam., the tips swollen up to 4–5 μ; spermatia minute, hyaline, globose, uniguttulate, 2.0–3.5 μ in diam. borne in a spermodochium (FIG. 8) made up of closely septate hyphae that give rise to numerous clusters of verticillately branched conidiophores ending in typical phialides.

Hosts: bulbs of *Tulipa* and *Narcissus* and roots of *Medicago sativa* L., *Melilotus alba* Desr., and *Melilotus officinalis* (L.) Lam.

Type. Dept. Agr. Ottawa Myc. Herb. *9015.* Apothecia developed in culture March–April 1940.

Co-type material deposited in the Herbarium of the University of Toronto; Plant Pathology Herbarium, Cornell University; Farlow Herbarium, Harvard University; Herbarium New York Botanical Garden; and Kew Herbarium.

Distribution: New York, Quebec, Alberta, Saskatchewan.

SUMMARY

Sclerotinia sativa is described as a new species. It causes a serious disease of tulip and narcissus bulbs and a root rot of alfalfa and sweet clover.

Successful cross-inoculations were made of the bulb and legume isolates.

Apothecia have not been observed in nature, but were obtained from cultures in the laboratory and greenhouse. It was demonstrated that the fungus is homothallic.

sectioning the apothecium.   The photograph used for figure 3 was taken by Mr. W. R. Fisher of Cornell University and the one for figure 8 by Dr. D. B. O. Savile.

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LITERATURE CITED

1. **Buller, A. H. Reginald.** The diploid cell and the diploidisation process in plants and animals with special reference to the higher fungi. I. Bot. Rev. **7**: 335–387. 1941.

2. **Cormack, M. W.** On the invasion of roots of *Medicago* and *Melilotus* by *Sclerotinia* sp. and *Plenodomus Meliloti* D. & S. Can. Jour. Res. **11**: 474–480. 1934.

3. ———. Varietal resistance of alfalfa and sweet clover to root- and crown-rotting fungi in Alberta. Sci. Agr. **22**: 775–786. 1942.

4. **Drayton, F. L.** The perfect stage of *Botrytis convoluta*. Mycologia **29**: 305–318. 1937.

5. **Godfrey, George H.** Gray mold of castor bean. Jour. Agr. Res. **23**: 679–715. 1923.

6. **Groves, J. W. & F. L. Drayton.** The perfect stage of *Botrytis cinerea*. Mycologia **31**: 485–489. 1939.

7. **Honey, Edwin E.** The monilioid species of *Sclerotinia*. Mycologia **20**: 127–157. 1928.

8. **Jagger, Ivan C.** *Sclerotinia minor,* n. sp., the cause of a decay of lettuce, celery, and other crops. Jour. Agr. Res. **20**: 331–334. 1920.

9. **Keay, Margaret A.** A study of certain species of the genus *Sclerotinia.* Ann. Appl. Biol. **26**: 227–246. 1939.

10. **Ramsey, G. B.** *Sclerotinia intermedia* n. sp. a cause of decay of salsify and carrots. Phytopath. **14**: 323–327. 1924.

11. ———. *Sclerotinia* species causing decay of vegetables under transit and market conditions. Jour. Agr. Res. **31**: 597–632. 1925.

12. **Weiss, Freeman.** *Ovulinia,* a new generic segregate from *Sclerotinia.* Phytopath. **30**: 236–244. 1940.

13. **Whetzel, H. H.** *Septotinia,* a new genus of the Ciborioideae. Mycologia **29**: 128–146. 1937.

ADDITIONS TO FLORIDA FUNGI

William A. Murrill

Specimens cited in this paper are permanently deposited in the herbarium of the Florida Agricultural Experiment Station, at Gainesville. The nomenclature is that used by the author in "North American Flora," but at the close of the paper certain species are transferred to genera more familiar to those using Saccardo. Dr. Rolf Singer has kindly allowed me to use some of his notes on microscopic characters.

Clitocybe peralbida sp. nov.

Pileo convexo ad infundibuliformi, gregario, albo, 2 cm. lato, amaro; lamellis angulatis, distantibus, denticulatis, albis; sporis ellipsoideis, 4–6 × 2–4 μ; stipite albo, glabro, 2–3 × 0.25–0.3 cm.

Pileus regular, convex to infundibuliform or depressed, gregarious, about 2 cm. broad; surface dry, smooth, milk-white, unchanging, finely pruinose, margin even, entire, incurved; context thin, white, odorless, sweet, becoming bitter and mawkish; lamellae tapering behind, narrow, distant, inserted, denticulate, white, yellowish when dry; spores ellipsoid, smooth, hyaline, 4–6 × 2–4 μ; stipe equal, smooth, glabrous, white, unchanging, 2–3 × 0.25–0.3 cm.

Type collected by West and Murrill on dead hardwood in Kelley's Hammock, ten miles northwest of Gainesville, Fla., July 19, 1938 (F *17911*). A beautiful white species, looking like dainty fairy cups set out on a log. In dried specimens the white teeth stand out conspicuously along the edges of the yellowed gills.

According to Singer, "Epicutis of repent, strongly diverticulate (up to almost 4 μ high), thin hyphae. Some cystidioid bodies reach the epicutis. Hyphae of context with thin or moderately thickened walls, non-amyloid, with clamp connections. Gill-trama regular, of thin hyphae; cheilocystidia versiform, not striking, rather scattered, irregularly basidiomorphous or filamentous; edge of lamella subhomomorphous; cystidia well-developed, long-clavate, with a slightly thickened wall, arising from the trama, smooth, hyaline, 45–55 × 6.8–8 μ; basidia 4-spored, 25–37 × 6.7–7.5 μ; spores smooth, hyaline, guttulate, non-amyloid, 6.7–7.5 × 3.5–4.3 μ."

Crepidotus albissimus sp. nov.

Pileo reniformi, convexo, 8–12 × 6–8 mm., glabro, fibrilloso, albo; lamellis adnatis, albis; sporis ellipsoideis, 5–7 × 3–4 μ.

Pileus reniform, convex, attached by a tubercle, gregarious, 8–12 × 6–8 mm.; surface dry, smooth, silky-fibrillose, very white and unchanging; margin entire, even, fibrillose, incurved; context white, unchanging; lamellae adnate, rather broad behind, medium distant, inserted, fimbriate on the edges, white, whitish when dry; spores ellipsoid, smooth, nonguttulate, about 5–7 × 3–4 μ.

Type collected by W. A. Murrill on a dead hardwood branch in a high hammock at Gainesville, Fla., June 28, 1938 (F *17281*). A striking pure-white species which does not become discolored on drying.

According to Singer, "Cuticle of repent, filamentous, thin hyphae with clamp connections; cystidia none; cheilocystidia scattered, subfilamentous, hyaline, 4–5 μ broad; basidia 24–30 × 6–7 μ; spores brownish, smooth, with simple, rather thin wall, 6.8–7.3 × 4–4.7 μ."

Galerula magnispora sp. nov.

Pileo convexo, 1 cm. lato, glabro, isabellino; lamellis adnatis, latis, fulvis; sporis ellipsoideis, fulvis, 15–20 × 10–12 μ; stipite albo, glabro, 3–4.5 × 0.12–0.2 cm.

Pileus convex, not expanding, gregarious, reaching 1.2 cm. broad; surface moist, smooth, glabrous, isabelline, estriate, margin even, entire; context thin, odor not characteristic; lamellae adnate, broad, ventricose, medium distant, inserted, entire, soon becoming fulvous; spores ellipsoid, smooth, opaque, fulvous, 15–20 × 10–12 μ; stipe slightly enlarged below, hollow, smooth, glabrous, white, shining, 3–4.5 × 0.12–0.2 cm.

Type collected by W. A. Murrill on old cow dung in a hammock south of Gulf Hammock, Levy Co., Fla., Mar. 8, 1942 (F *19841*). Found but once. The spores are larger than in any other American species of my acquaintance.

According to Singer, "Spores 11.3–17.5 × 8–10 μ, deep-ferrugineous, with a large germ-pore and distinctly truncate, with a double, smooth wall. Basidia short, 21.5–34 × 12.7–14 μ, the majority 4-spored but among them numerous 2-spored and 3-spored ones. Cheilocystidia fusoid-ventricose, the apex contracted into a thin neck the tip of which is thickened into a globulose appendix 3–3.8 μ diam., entire length 20.7–27.5 μ, largest diameter 6.8–7.8 μ. Cystidia none. The hymenium forms no needle-like crystals in ammonia

(15 min.). The epicutis of the pileus consists of an hymeniform layer of piriform cells (e gr. $33 \times 20 \mu$). The epicutis of the stipe consists of numerous, versiform but not capitate (fusoid, cylindric, subampullaceous, clavate) dermatocystidia or so-called 'hairs,' which are hyaline. Hyphae with clamp connections."

Galerula semiglobata sp. nov.

Pileo semigloboso, 1 cm. lato, isabellino; lamellis latis, subdistantibus, sporis ellipsoideis, $8–9 \times 4–5 \mu$; stipite pallido, 1×0.1 cm.

Pileus hemispheric, solitary, 1 cm. broad; surface slightly viscid, subglabrous, smooth, uniformly pale-isabelline, margin straight, even, entire; context membranous, pallid, odorless; lamellae sinuate, slightly ventricose, very broad, inserted, rather distant, pallid to isabelline, the edges white and fringed; spores ellipsoid, smooth, yellowish-brown, usually granular, about $8–9 \times 4–5 \mu$; stipe equal, smooth, glabrous, whitish-tomentose at the base, 1 cm. long, scarcely 1 mm. thick.

Type collected by West and Murrill on dead oak wood in a hammock at Arredonda, Fla., July 29, 1938 (F *17984*). Perfectly hemispheric, with beaded gills. Dried specimens resemble *Naucoria*.

According to Singer, "Spores $6.7–9 \times 3.5–5 \mu$, smooth, rather thin-walled, melleous, subglobose (rarely) to reniform, without a germ-pore. Basidia $13.5–22 \times 6.7–7.2 \mu$. Cheilocystidia clavate or filamentose with a large, rounded, capitate apex, or subfusoid-cylindric with rounded apex, numerous, hyaline to pale-melleous, smooth, $47–65 \times 6.8–11.5 \mu$. Cystidia none. Epicutis of the pileus formed by fusoid or subfusoid, not distinctly incrusted and not very thick-walled (wall $0.4–0.6 \mu$), erect or semi-erect dermatocystidia, the terminal portion (from the last septum) $65–70 \times 8–10 \mu$; clamp connections constantly present."

Gymnopilus dryophilus sp. nov.

Pileo 3–5 cm. lato, hispido-squamuloso, flavo; sapore grato; lamellis pallide-luteis; sporis ellipsoideis, ferrugineis, $6–7 \times 3.5–5 \mu$; stipite subfibrilloso, pallide-luteo, 5–7 cm. longo.

Pileus convex to subexpanded, cespitose, 3–5 cm. broad; surface dry, hispid-squamulose, especially at the center, becoming fibrillose or subsquamulose with age, pale flavous to darker, margin even, entire; context pallid, mild; lamellae adnate with decurrent tooth, broad, not crowded, entire, pale luteous; spores ellipsoid, finely granular, uniguttulate, ferruginous, $6–7 \times 3.5–5 \mu$; stipe equal or tapering upward, dry, smooth, slightly fibrillose, pale luteous, opaque, varying in thickness, about 5–7 cm. long.

Type collected by Lillian Arnold and Erdman West on an oak log at Gainesville, Fla., Dec. 14, 1931 (No. F *15735*). Also collected several other times about Gainesville on dead oak wood. Suggesting *G. penetrans* in form and habit of growth, but not found on pine and conspicuously speckled with erect, pointed scales.

According to Singer, "Type specimens are not good for study of gill-edge. I have studied the Camp O'Leno specimens. Cheilocystidia fusoid-bottle-shaped, 19–28 × 4.5–9.5 μ, hyaline, smooth, thin-walled, neck 3.5–11.3 × 2–4 μ. Basidia 20–27 × 6.8–8 μ, 4-spored. Cystidia none. Gill-trama bright-yellow in NH₃, coloring the ammonia yellow in preparations of the hymenium."

Gymnopilus fulvicolor sp. nov.

Pileo convexo-plano, 5 cm. lato, fulvo; lamellis adnatis, ferrugineis; sporis subglobosis, ferrugineis, 6 × 5–5.5 μ; stipite albo, 4 cm. longo.

Pileus convex to plane, gregarious, about 5 cm. broad; surface dry, smooth, glabrous, uniformly fulvous, margin even, entire; lamellae adnate, rather broad, not crowded, entire, ferruginous; spores subglobose or broadly ellipsoid, finely granular, uniguttulate, ferruginous, 6 × 5–5.5 μ; stipe rather short and slender, equal, smooth, subglabrous, white, about 4 cm. long.

Type collected by W. A. Murrill in leaf-mold among sticks under pines at Gainesville, Fla., Jan. 8, 1938 (F *16005*). Suggesting *G. penetrans* when first seen because of its shape and color but different in habit and totally distinct when dry, losing its bright colors and becoming dull brownish all over.

According to Singer, "Cuticle of irregular repent to suberect hyphae with clamps, some swollen, the terminal ones often cystidioid. Cystidia in hymenium none. Cheilocystidia basidiomorphous, scattered, indistinct, hyaline or brownish, 4–7 μ broad. Basidia 26 × 7–8 μ, 4-spored. Spores subglobose, warty, ferrugineous, 5.5–7–(8) × 4.5–5.5 μ."

Naucoria praeumbonata sp. nov.

Pileo convexo, umbonato, 2.5 cm. lato, cremeo; lamellis sinuatis, sub-distantibus; sporis 7 × 4 μ; stipite albo, 6 × 0.2 cm.

Pileus convex to subexpanded with large conic umbo, gregarious, 2.5 cm. broad; surface dry, smooth, finely innate-fibrous, dark-cremeous, margin even, entire; context membranous, odorless; lamellae sinuate with decurrent tooth, broad behind and close to the stipe, inserted, subdistant, entire, dark-isabelline; spores ellipsoid, granular, isabelline, about 6–8 × 4–5 μ; stipe cartilaginous, hollow, equal, smooth, glabrous, white, shining, 6 × 0.2 cm.

Type collected by West and Murrill in leaf-mold in Sanchez Hammock, eleven miles northwest of Gainesville, Florida, July 23, 1938 (F *17952*).   The cap is yellowish with a very prominent umbo and the stem is shining-white.   Some might refer it to *Cortinarius*.

According to Singer, "Cheilocystidia versiform, mostly bottle-shaped, sometimes vesiculose, neck short if present, hyaline to brownish, 17–32 × 10–13 μ. Spores without 'plage' (smooth place near the hilar appendix), verrucose, ferrugineous, 7.5–8 × 4.5–5.5 μ. Basidia 24–27 × 7.5 μ, 4-spored. Cuticle not much differentiated, of repent hyphae of medium size; clamps present."

Pholiota alachuana sp. nov.

Pileo convexo, 2.5 cm. lato, rugoso, melleo; sporis ellipsoideis, 10 × 5–6 μ; stipite albo, 7 cm. longo, annulo magno.

Pileus convex, not expanded, solitary, 2.5 cm. broad; surface glabrous, conspicuously rugose, pale melleous, margin even, undulate; context thin, pallid, sweet; lamellae adnexed, rounded behind, inserted, rather narrow, crowded, dirty-isabelline, the edges white; spores ellipsoid, smooth, not truncate and rarely guttulate, pale ferruginous, about 10 × 5–6 μ; stipe tapering upward, milk-white, floccose-fibrillose, 7 × 0.3–0.7 cm.; annulus large, white, membranous, apical, skirt-like, persistent.

Type collected by West, Arnold and Murrill on the top of a rotten hardwood log in Planera Hammock, eleven miles northwest of Gainesville, Fla., July 16, 1938 (F *17857*).   The single specimen collected was not quite mature enough to be fully expanded. My first thought was of *Armillaria mellea*, but the gills were too dark.   *Pholiota* is very rare in Florida.   The cuticle of the pileus in this species is hymeniform, consisting of piriform cells arranged in a palisade.

Pholiota floridana sp. nov.

Pileo convexo-subexpanso, 5 cm. lato, glabro, subviscido, subisabellino; lamellis adnexis, separantibus, ventricosis, pallidis; sporis ovoideis, 6–8 × 3–5 μ; stipite pallide, glabro, 6 × 1 cm.; annulo amplo, pallido, centrali.

Pileus convex to subexpanded, solitary, 5 cm. broad; surface smooth, glabrous, somewhat viscid, uniformly pale-isabelline, margin concolorous, even, splitting at times with age; context very thin, pallid, unchanging, taste mild, odor earthy and disagreeable,

at least when old; lamellae adnexed, rounded behind, at length separating from the stipe, ventricose, broad, medium close, entire, pallid; spores ovoid or elongate-ovoid, smooth, subferruginous, 6–8 × 3–5 μ; stipe slightly enlarged and concolorous with the pileus below, pallid and subshining above the annulus, smooth, glabrous, about 6 × 1 cm.; annulus ample, pallid, persistent, simple, fixed near the center of the stipe.

Type collected by W. A. Murrill in low woods of oak, hickory, etc., near Seven-mile Church, west of Gainesville, Fla., Dec. 16, 1941 (F *19694*). Found but once; on the ground but possibly attached to buried wood. Its nearest relative is perhaps *P. Johnsoniana*.

According to Singer, "Epicutis of repent, hyaline, smooth hyphae. Cheilocystidia vesiculose. Hymenium in very bad condition, not fit for study. Spores very few, of rather different sizes and tints—dubious."

Pluteolus citrinus sp. nov.

Pileo convexo-depresso, 1.5–2 cm. lato, viscido, sulcato, citrino; lamellis adnexis, confertis, sulphureis; sporis ellipsoideis, 12–14 × 7–8 μ; stipite sulphureo, bulboso, 3–5 × 0.15–0.2 cm.

Pileus convex to deeply depressed, not umbonate, scattered, 1.5–2 cm. broad; surface slimy-viscid, conspicuously sulcate to the disk, uniformly citrinous, becoming avellaneous with age; margin straight when young, entire to ragged; context extremely thin, fleshy, fragile, pallid, mild; lamellae adnexed, rounded behind, close, very narrow, inserted, entire, sulfureous, becoming isabelline with age; spores ellipsoid, truncate, smooth, 1-guttulate, deep-ferruginous, 12–14 × 7–8 μ; cystidia none; stipe equal above the small rounded bulb, fleshy, hollow, furfuraceous, sulfureous, smooth, not viscid, about 3–5 × 0.15–0.2 cm.; bulb about 3 mm.

Type collected by W. A. Murrill on a grassy, shaded lawn in Gainesville, Fla., Feb. 18, 1939 (F *19335*). It differs from most of our other species in having a comparatively short stem and growing in thick grass. The stipe is not cartilaginous but fleshy and fragile, and the gills are adnexed. The spores, however, are very typical for the genus.

According to Singer, "Cheilocystidia vesiculose, smooth, hyaline, 17–28 μ. Epicutis of pileus consisting of vesiculose-stipitate bodies which form an hymeniform layer. They are hyaline, 23–27 × 9–11 μ. Basidia are 4-spored."

Drosophila australis sp. nov.

Pileo convexo, subfulvo, glabro, 6 cm. lato, appendiculato; lamellis adnatis; sporis ellipsoideis, 7–8 × 4 μ; stipite pallido, canaliculato, 4.5 × 2 cm.

Pileus convex, solitary, 6 cm. broad; surface smooth, glabrous, shining, uniformly pale-fulvous; margin even, incurved, conspicuously appendiculate with triangular white flaps from the veil, which leaves a mere trace on the stipe; context thick, white, unchanging, taste mild, odor none; lamellae adnate or slightly sinuate, long-decurrent in raised lines, arcuate to nearly plane, inserted, crowded, reaching 7 mm. broad behind, thin, entire, pallid to purplish; spores ellipsoid, often convex-plane, mostly uniguttulate, purplish-brown, about 7–8 × 4 μ; cystidia none; stipe subequal, solid, firm, glabrous, pallid, canaliculate throughout, the ridges 2–3 mm. apart, 4.5 × 2 cm.

Type collected by W. A. Murrill west of Payne's Prairie, Alachua Co., Fla., on the top of a dead laurel-oak log in a low, dense live-oak hammock, March 1, 1942 (F *18719*). A distinct and striking species; found but once.

According to Singer, "Hyphae of the cuticle repent, elongate, radiately arranged; clamps present. Cheilocystidia of the same kind as the cystidia, but many hyaline ones and smaller ones are among them. Edge of gills subheteromorphous. Cystidia numerous, yellow, ventricose-stipitate, the thickest diameter not far from the base, gradually tapering upward with a rounded apex, or bottle-shaped with a long neck, 55–60 × 10–12 μ. Spores melleous as in *Flammula,* 6.5–8.7 × 3.7–4.5 μ, subreniform, smooth, without a germ-pore, not truncate."

Stropharia alachuana sp. nov.

Pileo convexo, 2.5 cm. lato, squamuloso, castaneo; lamellis adnexis, latis, confertis; sporis ovoideis, 4–4.5 × 2.5–3 μ; stipite solido, bulboso, albo, 4–5 × 0.15–0.3 cm.; annulo amplo, albo.

Pileus conic to convex, not expanding, cespitose, about 2.5 cm. broad; surface dry, densely finely squamulose, castaneous, disk slightly darker, margin incurved, even, undulate, not appendiculate; context thin, white, unchanging, sweet and nutty, without characteristic odor; lamellae just touching the stipe, rounded behind, plane, broad, very close, dark-brown at maturity with white, entire edges; spores subovoid, inequilateral, smooth, opaque, purplish-brown, 4–4.5 × 2.5–3 μ; cystidia none; stipe equal above the small bulb, solid, cottony, white, yellowish-brown when bruised, about 4–5 × 0.15–0.3 cm.; veil apical, ample, membranous, white, persistent.

Type collected by R. C. Hindery and E. West on rich humus under oaks in Sugarfoot Hammock, near Gainesville, Fla., Aug. 21, 1942 (F *19978*). Some might refer it to *Agaricus*.

According to Singer, "Cheilocystidia numerous but rather inconspicuous, hyaline, clavate to vesiculose, often transversely septate, measuring 11–17 μ from the last septum to the tip and 6–8 μ broad. Imbedded pleurocystidia not seen. Basidia destroyed. Spores not really truncate, with a very indistinct germ-pore, 4.5–5 × 3–3.5 μ."

Stropharia floridana sp. nov.

Pileo convexo-depresso, late umbonato, 2–3 cm. lato, roseo-isabellino; sapore et odore gratis; lamellis sinuatis, latis, violaceo-murinis ad atro-fumosis; sporis ovoideis, glabris, purpureo-brunneis, 8.5–11 × 5–6 μ; stipite albo, 4 × 0.3 cm.; annulo supero, albo, persistente.

Pileus convex to depressed, usually broadly umbonate, gregarious, 2–3 cm. broad; surface smooth, glabrous, moist but not viscid, opaque, rosy-isabelline, darker and duller with age and having a few yellowish stains; margin even, entire, becoming uplifted and undulate or lobed with age; context thin, white, rosy beneath the cuticle, odor pleasant, taste mild; lamellae sinuate, broad, ventricose, inserted, violet-murinous to dark fumosous; spores purplish-brown in mass, ovoid, smooth, 8.5–11 × 5–6 μ; stipe equal, often bent, smooth, glabrous, milk-white, hollow or stuffed, 4 × 0.3 cm.; annulus superior, white, fringed, fixed, persistent.

Type collected by Erdman West and W. A. Murrill on the ground in oak woods at Gainesville, Fla., Nov. 12, 1932 (F *10170*). About twenty specimens were collected, allowing a study of all stages.

According to Singer, "Epicutis hyaline, of 1–4 μ, rarely thicker hyphae, which are repent, with clamp connections. The epicutis is partially washed off; the subcutis subintermixed, of broad, melleous hyphae, some short and swollen (e gr. 33–47 × 16–17 μ), but most of them elongate-fibrillose; spherocysts none. Cheilocystidia 32–37 × 6–6.8 μ, ventricose-capitate, hyaline, smooth, apical portion 4.5–6 μ in diam. Edge of gills not truly hetero-morphous. Cystidia not seen. Trama decidedly regular, but hyphae rather broad and interwoven. Spores deep melleous-olivaceous, with double wall, smooth, with germ-pore but not distinctly truncate, narrowed toward the upper end, 8.7–10.7 × 4–4.7 μ, some somewhat broader when seen frontally than in profile. Basidia 24–29 × 6.7–8 μ, 4-spored."

Psathyrella alachuana sp. nov.

Pileo convexo-expanso, umbonato, 1.5 cm. lato, pallido, glabro, striato; lamellis adnexis, latis, pallidis; sporis ellipsoideis, 11 × 7 μ; stipite albo, glabro, 4–6 × 0.1 cm.

Pileus convex to expanded, umbonate, gregarious, 1.5 cm. broad; surface glabrous, pallid when young, dark-brown when mature and moist, fading when dry, margin widely striate, abruptly upturned; context membranous; lamellae adnexed, rounded behind, broad, ventricose, rather distant, inserted, white to blackish, edges minutely notched and fringed; spores ellipsoid, smooth, black, opaque, about 11 × 7 μ; stipe slightly enlarged below, hollow, fragile, smooth, glabrous, white, unchanging, about 4–6 × 0.1 cm.

Type collected by W. A. Murrill on an open grassy lawn in Gainesville, Fla., July 5, 1942 (F 18516). A small, fragile species resembling *Coprinus*. At maturity the pileus suggests a wide, flat hat with a small crown and upturned brim.

According to Singer, "Spores brownish-black, 10.7–13.4 × 6.7–7.5 μ, ellipsoid, in a certain position sometimes subrhomboid, with thick, smooth wall, discolored in concentrated H_2SO_4, with truncate germ-pore. Two-spored basidia present. Cheilocystidia 27–32 × 9–18 μ, broadly fusoid or bottle-shaped with broadly rounded apex, hyaline, smooth. Cystidia none. Cuticle cellular, the cells about 20–28 μ in diam., subhyaline. Dermatocystidia of the stipe irregularly vesiculose, some more clavate (27 × 14 μ) or tapering from a swollen base, hyaline."

NEW COMBINATIONS

For those using Saccardo's nomenclature the following new combinations are made:

Drosophila australis	= Hypholoma australe
Galerula magnispora	= Galera magnispora
Galerula semiglobata	= Galera semiglobata
Gymnopilus dryophilus	= Flammula dryophila
Gymnopilus fulvicolor	= Flammula fulvicolor

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INDIAN SPECIES OF PHAKOPSORA
AND BUBAKIA

B. B. Mundkur

The genus *Phakopsora* was founded by Dietel (1895) to accommodate a rust on *Galium Aparine* collected by Barclay at Simla. The rust was first named *Melampsora punctiformis* Barclay and Dietel, apud Dietel (1890), but five years later Dietel considered it to be sufficiently different as to deserve a new genus for its reception. *Phakopsora punctiformis* (Barclay & Dietel) Dietel is, however, known only from the type collection and this unfortunately is not available in any Indian herbaria.

About thirty-six species of *Phakopsora* have so far been described but of these nearly eight have either been reduced to synonymy within the genus or transferred to some other genera. Butler and Bisby (1931) record four species for India but a study of collections made recently indicates that there are four more species, of which two are new records for India and two are proposed as new species.

Representatives of the genus *Bubakia* have not so far been recorded for India but the merging of the genus *Schroeteriaster* into *Uromyces* by Mains (1934) has necessitated an examination of the two Indian species of the genus, *Schroeteriaster cingens* Sydow and *Schroeteriaster Ehretiae* (Hiratsuka) Sydow & Butler. Both of them belong to *Bubakia,* of which one is proposed as a new combination.

The position of *Bubakia* appears to be rather uncertain. Proposed by Arthur (1906) in 1905, he (1917) changed his views regarding the value of characters drawn from the protective structure of the uredium for generic diagnoses and merged the genus into *Phakopsora.* But he again reversed his (1934) opinion and restored *Bubakia* to independent generic rank. Hiratsuka (1935) has made it a sub-genus of *Phakopsora* but Dietel (1928), Jackson (1931), and Cummins (1936, 1940) have continued to keep it separate.

The principal characters on which *Bubakia* has been separated from *Phakopsora* are the absence of paraphyses and pseudoperidia in the uredia and the presence of equatorial germ pores in the urediospores. Germ pores may or may not be present in the urediospores of *Phakopsora* but if they are, they are very obscure. In their telial characters both the genera show very close resemblance. While the characters of the telium have the most weight in establishing the position of genera in the Uredinales, the combination of other easily comprehensible characters in *Bubakia* and their absence in *Phakopsora,* and *vice versa,* justifies the retention of the former as a separate genus. The complete life histories of both these genera were not until recently fully known. Jackson (1931) reported sub-cuticular pycnia and uredinoid aecia in *Bubakia argentensis* (Speg.) Jackson & Holway, and Cummins (1940) in *Bubakia Ehretiae* (Hiratsuka) S. Ito and thus showed that some species of the genus are autoecious. I have found uredinoid aecia in the species of *Phakopsora* on *Stereospermum suaveolens,* thus partly completing the life history of the genus; its diagnosis has therefore been emended.

PHAKOPSORA Dietel, Ber. Deuts. Bot. Ges. 1895, **13**: 333; in E. & P. Nat. Pfl. II Aufl. 1928, **6**: 42; Magnus, Ber. Deuts. Bot. Ges. 1896, **14**: 129; Arthur, Résult. Sci. Congr. Bot. Vienne, **1906**: 339; Bull. Torrey Club 1917, **44**: 508; Hiratsuka, Bot. Mag. Tokyo, 1935, **49**: 783, 853; 1936, **50**: 1; Cummins, Mycologia, 1936, **28**: 119; 1940, **32**: 370; Mains, Mycologia, 1938, **30**: 45.

Pycnia unknown. Aecia uredinoid, sub-epidermal, aparaphysate, without peridia, erumpent, aeciospores arising in chains. Uredia covered by a peridium opening at the apex by a circular hole, or by a thick crown of paraphyses, later erumpent; paraphyses when present peripheral, either free and incurved or imbricated by the union of their bases and free part extending into the sorus forming a pseudoperidium or in part entirely replaced by a membranous peridium; urediospores arising singly on pedicels, germ pores obscure. Telia indehiscent, rarely erumpent, forming lenticular masses, two or more cells thick at centre, oblong, slightly coloured, smooth.

A

Type species: *Phakopsora punctiformis* (Barclay & Dietel) Dietel on *Galium Aparine,* Simla, India.

1. PHAKOPSORA AMPELOPSIDIS Dietel & Sydow, apud Dietel, Hedwigia, 1898, **37**: 217; Hiratsuka, Bot. Mag. Tokyo, 1900, **14**: 89; Sacc. Syll. Fung. **14**: 289; Sydow, Monogr. Ured. 1915, **3**: 412; Hiratsuka, Bot. Mag. Tokyo, 1935, **49**: 857.

   Syn. *Uredo Vitis* Thümen, Pilze Weinst. **1878**: 182.
   Uredo Vialae Lagerheim, Compt. Rend. Acad. Sci. Paris, 1890, **110**: 729.
   Phakopsora Vitis Sydow, Hedwigia, 1899, **38**: 141.
   Physopella Vitis Arthur, Résult. Sci. Congr. Bot. Vienna, **1906**: 338.

On *Vitis semicordata* Roxb. Mussoorie, U.P., 6–8–1925, leg. A. H. Khan. Only uredia are present, which agree in all respects with those on the type of *Phakopsora Vitis* Syd. and not with those of *Phakopsora cronartiiformis* (Barclay) Dietel.

Hiratsuka (1900) who made a critical study of the Japanese (type) material concluded that there is no good reason to distinguish *Phakopsora Ampelopsidis* from *Phakopsora Vitis.*

2. PHAKOPSORA ARTEMISIAE Hiratsuka, Japanese Jour. Bot. 1927, **3**: 298; Bot. Mag. Tokyo, 1935, **49**: 854.

   Syn. *Uredo Artemisiae-japonicae* Dietel, Bot. Jahrb. 1905, **34**: 591.
   Uredo autumnalis Dietel, Bot. Jahrb. 1905, **37**: 108.
   Phakopsora circumvallata Sawada, Descr. Cat. Formosan Fungi, 1931, **5**: 49.

On *Artemisia vulgaris* L. Molta (U.P.), 2–10–1934, leg. K. Bagchee.

The Indian collection agrees fairly well with Hiratsuka's description, the type being not available for comparison. The telia are not entirely indehiscent and the teliospores separate into individual cells when mature, a character not mentioned by Hiratsuka (1927).

3. PHAKOPSORA CRONARTIIFORMIS (Barclay) Dietel, Ann. Myc. 1912, **10**: 385; Sacc. Syll. Fung. **23**: 844; Sydow, Monog. Ured. 1915, **3**: 412; Butler & Bisby, Fungi of India **1931**: 62.

Syn. *Uredo cronartiiformis* Barclay, Jour. Asiatic Soc. Bengal,
1890, **59**: 98.

Phakopsora Vitis Butler (nec Sydow), Ann. Myc. 1912,
10: 153.

On leaves of *Parthenocissus himalayana* Planch (= *Vitis hima-layana* Brandis) Mussorie, 10–9–1911, leg. E. J. Butler; Ramgarh,
Kumaon, 23–10–1920, leg. S. D. Joshi; on *Vitis divaricata* Wall.,
Naini Tal, leg. J. H. Mitter.   Reported to be on *Vitis semicordata*
Roxb. in the Madras presidency, but specimen not seen.

4. **Phakopsora Odinae** Mundkur, sp. nov.

Uredia amphigena, plerumque hypophylla, minuta, circularia, sub-epider-
malia, postea erumpentia, pallide flava; urediosporae ovatae, vel subglobosae,
verrucosae, dilute flavo-brunneae, 14.3–16.5 × 11–14.3 μ; paraphyses pe-
ripherales, clavatae, hyalinae, robustae. Telia amphigena, plerumque hypo-
phylla, minuta, fusco-brunnea, sparsa, vel raro aggregata, subepidermalia,
indehiscentia, raro erumpentia; unita lenticularium crustarum instar, sporis
2-5 alta; teliosporae oblongae vel promiscue cuboideae, sessiles, castaneo-
brunneae, inferiores vero cellulae pallidiores; cellula in apice denso pariete,
inferiores vero tenuiori pariete praeditae, magnitudinis 3.3–13.2 × 2.2–7.7 μ.

Typum invenit R. R. Sen in foliis viventibus Odinae Wodier Roxb. in
loco Chittagong, 2 Februarii, 1925, typus asservatur in Herb. Crypt. Ind.
Orient.

Uredia amphigenous but mostly hypophyllous, minute, round,
subepidermal, then erumpent, light yellow; urediospores ovate to
subglobose, verrucose, dilute yellowish-brown, 14.3–16.5 × 11–
14.3 μ; paraphyses peripheral, clavate, hyaline, stout.   Telia am-
phigenous, mostly hypophyllous, minute, dark brown, scattered or
rarely aggregate, subepidermal, indehiscent, rarely erumpent; united
into lenticular crusts, 2 to 5 spores high; teliospores oblong or
irregularly cuboid, chestnut-brown, sessile, lower cells paler, apical
cell thick-walled, lower thinner, 3.3–13.2 × 2.2–7.7 μ.

On living leaves of *Odina Wodier* Roxb. Chittagong, 9–2–1925,
leg. R. R. Sen.   Type deposited in the Herb. Crypt. Ind. Orient.
This is the first record of a *Phakopsora* on Anacardiaceae.

5. PHAKOPSORA PHYLLANTHI Dietel, Ann. Myc. 1910, **8**: 469;
Sydow & Butler, Ann. Myc. 1912, **10**: 269; Sacc. Syll. Fung.
21: 608; Sydow, Monog. Ured. 1915, **3**: 414; Butler & Bisby,
Fungi of India, 1931: 62.

On leaves of *Phyllanthus distichus* Muell. Godavery, 16–11–1907 (Type), leg. S. N. Mitra; Tanjore, 24–11–1909, leg. S. Sundararaman; Palghat, 16–12–1910, leg. L. S. Subramaniam; Dacca, 12–9–1912, leg. A. L. Som.

This rust does not have paraphyses in its uredia but a prominent peridium is present.

6. Phakopsora Stereospermi Mundkur, sp. nov.

Pycnia ignota. Aecia uredinoidea, hypophylla, subepidermalia, leviter erumpentia, absque paraphysibus vel peridiis, ad 0.6 mm. diam.; aeciosporae hyalinae, catenulatae, tenui pariete praeditae, rectangulares vel cuboideae, tenuiter echinulatae, 12–18 × 10–15 μ. Uredia amphigena, communiter hypophylla, subepidermalia, minuta, erumpentia, colore ex pallide flavo-brunneo ad intense brunneum, pariete ad 1.5 μ crasso, magnitudinis 23–31 × 15–21 μ; paraphyses intermixtae, tenues, cylindricae, subhyalinae, vel leviter flavo-brunneae, 34–61 μ longae. Telia subepidermalia, indehiscentia, lenticularium crustarum instar disposita (sporae in singulis catenis 2 ad 4), 91–129 μ longa atque 342–800 μ lata; teliosporae oblongae vel cuboideae, flavae, 13–33 × 8–15 μ, crasitudine 1.5–2.0 μ, spora in vertice praedita pariete superiori crassiori (3.5 μ).

Typum legit R. T. Pearl in foliis viventibus Stereospermi suaveolentis Wall. 13 Novembris 1922 in loco Nagpur; idem R. T. Pearl legit 17 Septembris 1922; typus asservatur in Herb. Crypt. Ind. Orient.

Pycnia unknown. Aecia uredinoid, hypophyllous, subepidermal, slightly erumpent, without paraphyses or peridia up to 646 μ in diameter; aeciospores hyaline, catenulate, thin-walled, rectangular or cuboid, finally echinulate. 12–18 × 10–15 μ. Uredia amphigenous, usually hypophyllous, subepidermal, minute, erumpent, pale yellowish-brown, pulverulent up to 600 μ in diameter; urediospores ovate, ellipsoid to oblong, echinulate, yellowish to deeply brown, wall up to 1.5 μ thick, 23–31 × 15–21 μ; paraphyses intermixed, slender, cylindrical, subhyaline, or slightly yellowish-brown, 34 to 61 μ long. Telia subepidermal, indehiscent, forming lenticular crusts, 2 to 4 spores in a column, 91 to 129 μ high and 342 to 800 μ in diameter; teliospores oblong to cuboid, yellow, 13–33 × 8–15 μ, from 1.5 to 2.0 μ thick, uppermost spore with extra thick, 3.5 μ, apical wall.

On living leaves of *Stereospermum suaveolens* Wall. Nagpur, 13–11–22 (aecia and uredia), and 17–9–1922 (uredia and telia), leg. R. T. Pearl (Type). Type deposited in Herb. Crypt. Ind. Orient

7. PHAKOPSORA ZIZYPHI-VULGARIS (P. Henn.) Dietel, Ann. Myc.
    1910, **8**: 469; Sacc. Syll. Fung. **21**: 608; Sydow & Butler,
    Ann. Myc. 1912, **10**: 269; Sydow, Monog. Ured. 1915, **3**:
    413; Butler & Bisby, Fungi of India, **1931**: 62; Hiratsuka
    Bot. Mag. Tokyo, 1935, **49**: 853.
    Syn. *Uredo Zizyphi-vulgaris* Henn. Hedwigia, 1902, **41**: (21);
        Sydow & Butler, Ann. Myc. 1907, **5**: 508.

On leaves of *Zizyphus jujuba* Lam. Pusa, 8–3–1910, leg. R. R.
Sen (Type); Nagpur, 18–10–1907, leg. P. A. Pandit; Birbhum,
3–1905, leg. S. K. Basu; Jalalpur (Punjab), 17–12–1917, leg.
G. S. Cheema; on leaves of *Zizyphus vulgaris* Lam. Hazara,
17–9–1930, leg. A. H. Khan; on *Zizyphus* sp. Chittagong, 17–2–
1928, leg. R. R. Sen.

SPECIMEN NOT SEEN AND AVAILABLE

8. PHAKOPSORA PUNCTIFORMIS (Barclay & Dietel) Dietel, Ber.
    Deuts. Bot. Ges. 1895, **13**: 333; Sacc. Syll. Fung. **14**: 289;
    Sydow, Monog. Ured. 1915, **3**: 408; Butler & Bisby, Fungi
    of India, **1931**: 62.
    Syn. *Melampsora punctiformis* Barclay & Dietel, apud Dietel,
        Hedwigia, 1890, **29**: 267.

On living leaves of *Galium Aparine* L., Simla, leg. A. Barclay.

BUBAKIA Arthur, Résult. Sci. Congr. Bot. Vienne, **1906**: 338; N.
    Am. Flora, 1907, **7**: 104; Manual of Rusts, **1934**: 59; Dietel,
    in E. & P. Nat. Pfl. 2 Aufl. **6**: 48; Jackson, Mycologia, 1931,
    23: 466; Cummins, Mycologia, 1936, **28**: 111, 127; 1940, **32**:
    370.

Pycnia subcuticular. Aecia uredinoid, subepidermal. Uredia
subepidermal, erumpent, pulverulent, without peridium or para-
physes; urediospores borne singly on pedicels, but apparently ap-
pearing sessile, obovate, with pale yellow echinulate walls, with up
to four equatorial, clearly visible germ pores. Telia indehiscent,
compacted into dense masses, several cells thick; teliospores one-
celled, smooth, thin-walled, yellowish, uppermost cell with thick
apical wall.

Type species: *Bubákia Crotonis* (Cooke) Arthur on *Croton californicus* in California, U. S. A.

9. Bubakia Ehretiae (Hiratsuka) S. Ito

  Syn. *Phakopsora Ehretiae* Hiratsuka, Bot. Mag. Tokyo, 1900,
        14: 92; *Schroeteriaster Ehretiae* (Hirat.) Sydow &
        Butler, Ann. Myc. 1912, **10**: 270; Sacc. Syll. Fung. **23**:
        842; Sydow, Monog. Ured. 1915, **3**: 405; Butler & Bisby,
        Fungi of India, **1931**: 7̃7.

On living leaves of *Ehretia acuminata* R. Br. Chittagong, 20–9–1911, leg. R. R. Sen.

10. **Bubakia cingens** (Sydow) Mundkur, comb. nov.

  Syn. *Uredo Brideliae* Koorders, Verhandl. Koninkl. Akad.
        Wetensch. Amsterdam, II. sect. Deel 1907, **13**: 201.
        Melampsora cingens Sydow, Ann. Myc. 1911, **9**: 143.
        Schroeteriaster cingens Sydow, Ann. Myc. 1912, **10**: 270;
        Monog. Ured. 1915, **3**: 404; Butler & Bisby, Fungi of
        India, **1931**: 77; Sacc. Syll. Fung. **23**: 841.
        Phakopsora Brideliae Arthur, Bull. Torrey Club, 1917,
        44: 508.
        Bubakia Brideliae Dietel, apud E. & P. Nat. Pfl. Aufl. II,
        1928, **6**: 48.

On living leaves of *Bridelia tomentosa* Bl. var. *chinensis* Muell-Arg. Rangpur, 27–2–1911, leg. A. L. Som (Type); Khasi Hills (Assam), 15–1–1915, leg. L. S. Subramaniam; Kumira, Chittagong, 16–2–1925, leg. R. R. Sen; on *Bridelia* sp. Mussoorie, 1912, leg. P. C. Kar.

SUMMARY

This paper reports the occurrence of eight species of *Phakopsora* and two of *Bubakia* in India. Two species of the former, *Phakopsora Odinae* and *Phakopsora Stereospermi,* are proposed as new species; the latter species is characterised by the presence of sub-epidermal aecia, which is the first record of this sorus for this genus. Of the two species of *Bubakia,* one is proposed as a new combination, *Bubakia cingens.*

I wish to place on record my indebtedness to Rev. Father H. Santapau, S.J., for his kindness in translating the diagnoses into Latin.

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REFERENCES

Arthur, J. C. Eine auf die Struktur und Entwicklungsgeschichte begrundete Klassification der Uredineen. Result. Sci. Congr. Bot. Vienne **1905**: 331–348. 1906.

Arthur, J. C. Relationships of the genus *Kuehneola*. Bull. Torrey Club **44**: 501–511. 1917.

Arthur, J. C. Manual of Rusts. Lafayette, Indiana, U. S. A., pp. 438. 1937.

Butler, E. J. & Bisby, G. R. Fungi of India. Sci. Monogr. Counc. Agric. Res. India **1**: 62–77. 1931.

Cummins, G. B. Phylogenetic significance of the pores in urediospores. Mycologia **28**: 103–132. 1936.

Cummins, G. B. Uredinales of New Guinea. Mycologia **32**: 359–375. 1940.

Dietel, P. Uredineen aus dem Himalaya. Hedwigia **29**: 259–270. 1890.

Dietel, P. Drei neue Uredineengattungen, *Masseeella, Phakopsora* und *Schizospora*. Ber. Deuts. Bot. Ges. **13**: 332–335. 1895.

Dietel, P. Hemibasidii, *in* Engler and Prantl's, Die natürl. Pflanzenf. II Aug. **6**: 24–98. 1928.

Hiratsuka, N. *Phakopsora* of Japan. Bot. Mag. Tokyo, I, 1935, **49**: 781–788; 1935, II, **49**: 853–860; 1936, III, **50**: 1–8.

Jackson, H. S. The Rusts of South America based on the Holway collections, V. Mycologia **23**: 463–503. 1931.

Mains, E. B. The status of the genus *Schroeteriaster*. Ann. Myc. **32**: 256–259. 1934.

STUDIES IN THE GASTEROMYCETES VIII.
BATTARREA LACINIATA

W. H. LONG

(WITH 6 FIGURES)

Battarrea laciniata has been listed as a synonym of *B. phalloides* by most scientists and was so considered by me until recently when a specimen of this genus was received from Las Cruces, New Mexico, some 8 miles from the type locality of *B. laciniata*. The Las Cruces plant when compared with the type material proved to be this species, which differs in many details from our common *Battarrea* in this country known as *B. phalloides*.[1]

In 1939 I collected more than 100 plants of a *Battarrea* in Antelope Valley on the edge of the Mohave Desert in California. These were so different from any of my other species of *Battarrea* that I could not identify them with certainty until a comparison was made with the type of *B. laciniata* which showed they were unquestionably this species. The Antelope Valley plants were in open, unshaded areas in rich dark loamy soil among *Atriplex* and other desert shrubs. The owner of the ranch on which the plants were growing, stated that this fungus was always found in the richest land on his place, a soil that did not pack even under the heaviest rains.

I am giving a technical description of *Battarrea laciniata* for use in comparing it with other known species of this genus. This emended description is made from the California material since it has an abundance of plants while the type is too fragmentary for all details to show. The glebal characters, however, capillitium, spores and elaters, were taken from the type material.

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[1] I am following Rea (1942) in calling our common *Battarrea, B. phalloides* and for the reasons given by him for such usage. I have never seen an American *Battarrea* with a gelatinous volva or stem, but if such a condition is really present in *B. phalloides* then our American form would be *B. Stevenii* which has a dry volva.

Battarrea . laciniata Underwood in White, Bull. Torrey Club **28**:
   439–440. 1901.

Sporophore 10–45 cm. tall when mature, originating 6–18 cm.
below the surface of the soil, usually robust at maturity. *Sporo-
carp* consisting of the endoperidium, the gleba and the greatly
expanded, discoid apex of the stem, 4–8 cm. wide by 2–4 cm. high,
often irregular in shape, pulvinate to applanate above, strongly
concave to cup-shaped beneath where it is creamy white to light
tan, enclosed when young in a volva hence not having a true exo-
peridium. *Endoperidium* smooth, tough, membranous, having a
patch of the outer volva cemented to its top; *dehiscence* occurring
as the sporocarp emerges from the ground, circumscissle around
the periphery of the discoid apex of the stem and falling away in
one piece as a distinct calyptra, which is usually found on the
ground near the plant after elongation. *Stipe* 8–40 cm. tall, 2–4
cm. thick at top by 1.5–2 cm. at base, woody, uniform or tapering
downward, sulcate to striate, outer coat fibrillose, peeling, often
scaly, hollow, inner surface of hollow with white silky lining, outer
layers dense, inner more porous with large cells. *Volva*[2] com-
plex, composed of a thick, outer coat or layer and an inner set of
numerous thin leaflets arranged in concentric layers about the base
of the stipe (FIGS. 1, 3); *outer volva* subglobose to obovate (FIG.
2), 6–10 cm. across by 3–9 cm. tall, often strongly inflated and
wrinkled, consisting of three distinct areas or zones, (1) a basal
portion of floccose-spongy tissue, dirty white outside but cream
color internally, (2) merging into an irregular equatorial band,
2–3 cm. wide of hard, leathery to horny tissue, becoming thinner
at the upper margin, often scaly, and (3) capped by a buff to
usually reddish, subcartilagenous tissue quite different from the
basal portion of the outer volva; this cap may be nearly smooth to
strongly scaly, the reddish color of the volva top usually extends
through to the surface of the endoperidium to which it is cemented.
When the stipe elongates, the enclosing volva splits along the line
of juncture of the upper part of the equatorial zone next to the
cemented top of the volva leaving a ragged edge around the line
of cleavage. This outer volva is very unique in having these 3
zones quite different from any thing seen by me in other species
of *Battarrea*. *Inner volva* cylindrical, surrounding the base of the
stem, consisting of. many concentric sheaths or layers which when
mature are composed of numerous thin leaflets of varying heights,
these leaflets are in two distinct groups—an outer with large tall

[2] This description was made from mature expanded plants, since I was
unable to find any young stages or "eggs."

leaflets and inner set of much smaller leaflets next to the base of the stem. This inner volva when fully mature consists of 2–3 whitish sheaths on the outside (FIG. 1 and 3), these may be 3–4 cm. tall, each successively taller than the preceding with eroded tops and usually breaking into very broad leaflets tightly clasping the next inner set of leaflets which are narrower, taller and more ribbon-like, darker in color with much laciniated tops and may become 4–7 cm. tall; then finally another very short set of leaflets is usually found next to the base of the stem, these short leaflets range from 1–2 cm. tall, are pointed and are from 1–4 mm. wide at their base; this set of leaflets is the last and innermost layer of this complex volva and often rots away under weathering. All of these leaflets arise from the white cheesy inner portion of the outer volva near the base of the stipe. *Gleba* reddish brown, usually with a disagreeable odor, consisting of capillitium, elaters and spores. *Capillitium* very sparse, hyaline, indefinite, irregular, and somewhat fascicular; *elaters* very numerous, whitish, 5–7 microns thick by 15–40 microns long, thickenings annular not spiral. *Spores* 5–7 microns in diameter, usual size 5.6 mic.; *epispore* chestnut brown, pitted but appearing smooth in water mountant.

Type locality: Mesilla Park, New Mexico.

Habitat: Solitary or rarely in groups of 2–3 individuals from hole made in soil by elongation of the plants, in open or rarely in partial shade of desert plants, in rich loamy alkaline soil; in arid or semi-arid regions.

Distribution: New Mexico, Dona Ana County, Mesilla Park, elevation 3865 feet, *T. D. A. Cockerell,* February 1898, *2 plants* in New York Botanical Garden, Type material; Las Cruces, elevation 3883 feet, *Dr. H. L. Barnett,* June 1939, *1 plant* in Long Herb. *10269.* California, Los Angeles County, 5 miles east and 2½ miles north of Lancaster, elevation 2350 feet, *O. A. Plunkett,* October 5, 1938, *1 plant* in Long Herb. *9345,* and *several plants* in the Plunkett Herb. at Los Angeles; *W. H. Long,* August 24–27, 1939, *101 plants,* of which *95* are in the Long Herb. *8410,* 2 in the University of California Herb. at Berkeley *62917,* and *4 plants* in the Morse Herb. at Berkeley; *Paul & Marian Rea,* November 10, 1941, *17 plants* in Herb. Paul & Marian Rea, *1011* at Santa Barbara, California.

The type material of *Battarrea laciniata* is meager and much mutilated, but enough is present to clearly define the species.
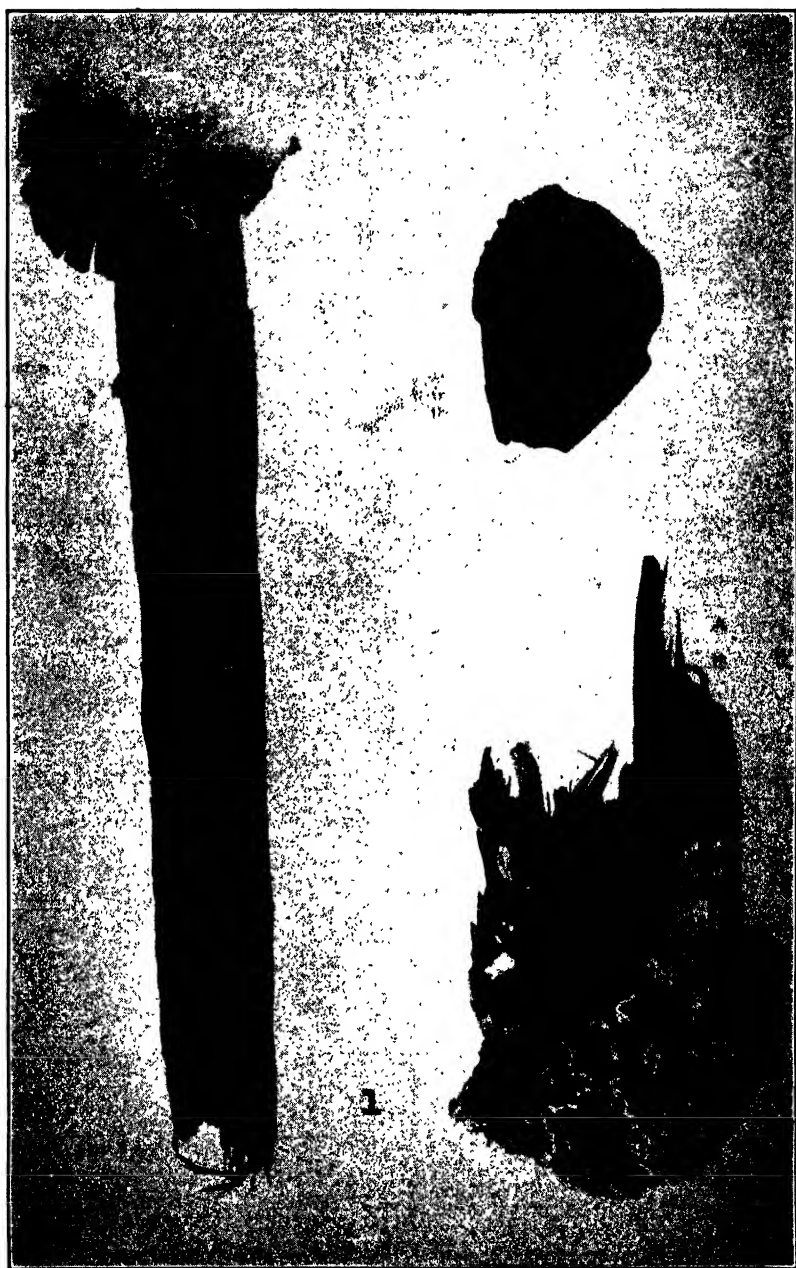
Fig. 1. *Battarrea laciniata* from type, × ⅞.

There are pieces of 2 sporophores, consisting of stems and the attached bases of the sporocarps, also an excellent basal volva (FIG. 1), showing the whitish remains of the outer volva, and a complete inner volva and a loose calyptra (FIG. 1) consisting of the shed top of the endoperidium with the attached, light buff, horny top of the outer volva. The volva of this type specimen has no equatorial band or zone as this was broken off either when the plant was collected or afterwards in handling. The outer volva has loamy particles of dirt still present in the wrinkles showing that it grew in a rich soil and not in sand.

The Las Cruces specimen (FIG. 2) is very similar to the type material. This plant is stout, a perfect specimen having stem, sporocarp, basal volva and calyptra; the 3 zones of the outer volva-basal, equatorial and top, are evident. The volva patch of the calyptra is light buff, horny and reticulate (FIG. 2), the basal volva is much inflated, with the upper margin of the equatorial zone lacerate and incurved, the inner volva is typical of this species. The stem scales are thin and fibrillose. According to Dr. Barnett the plant was growing in a rich, unshaded area.

In my California collection of *Battarrea laciniata* are individuals that range in form and size from tall, rather slender and tapering, to short, coarse, stout plants (FIG. 3); however as a whole these plants are stouter and more obese than my specimens of *B. phalloides*. The reddish cartilagenous volva is limited to the California plants and is not a constant feature even in this material; out of 119 calyptras in my collection, 76 are red while 43 are a dirty white to light buff. The type from Mesilla Park and the plant from Las Cruces, New Mexico, both have light buff tops on their calyptra, otherwise the plants are very similar to my California material. According to Dr. Rea, of the 17 plants collected by him in 1941 from the same California area as my plants, 12 had calyptras and of these, 7 were red and 5 white to gray. The above data show that the red volva patch of the calyptras is not constant.

I have examined many specimens of *Battarrea* from Arizona, New Mexico and California and find that the height of the plant, the size, shape and number of scales on the stipe are so variable that such characters are of little value in species determination, for instance in *Battarrea laciniata,* the size of the sporophores ranges
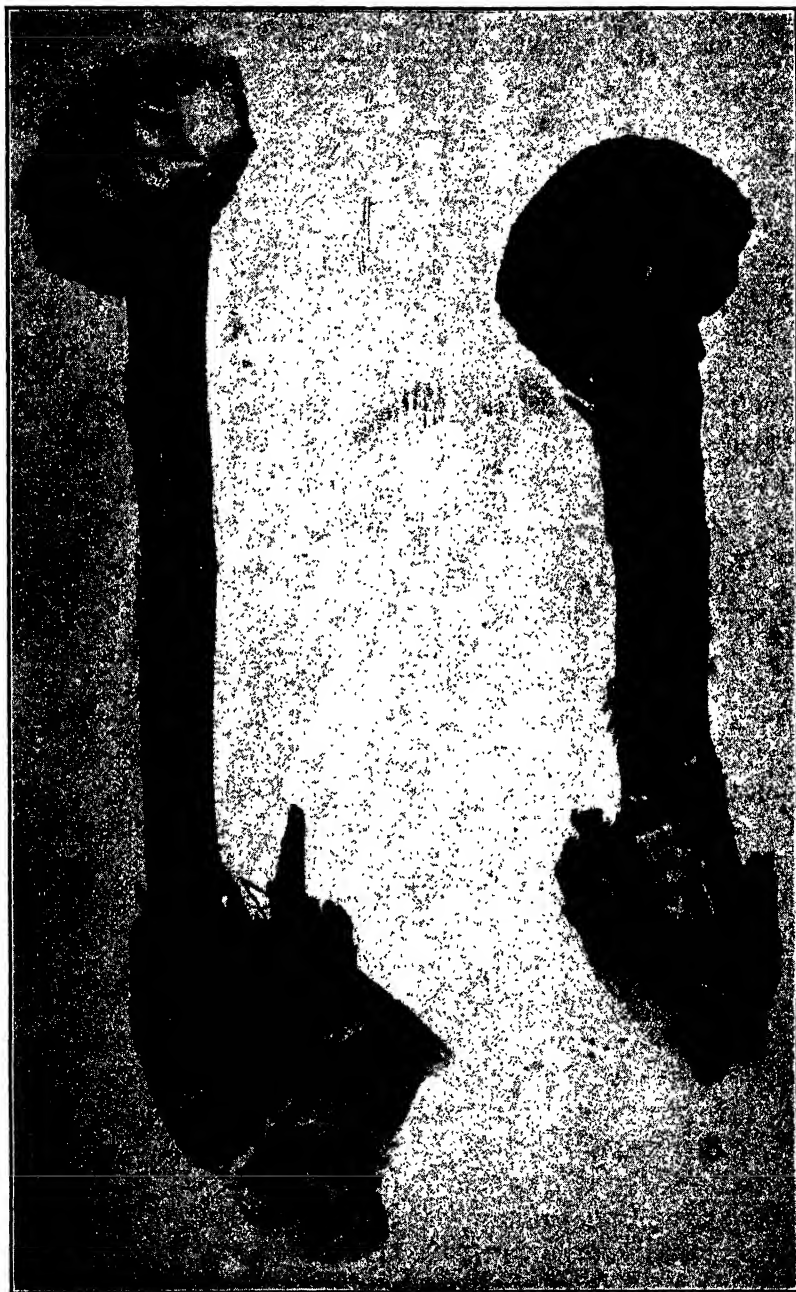
Figs. 2, 3. *Battarrea laciniata,* × ⅘.

from 10 cm. to 45 cm. tall, while the stem scales vary in size from very small to large well marked ones. The same is true for *B. Digueti* and for our common *B. phalloides*. Even in the same collection these characters are so variable that no diagnostic value can be placed on them. We must therefore look to other characters for separating our species. In *B. laciniata* the characters of· the volva are very marked and constant and are the only means of identifying this species, if held as valid; in *B. Digueti* the method of dehiscence by pores and the retention of the endoperidium are constant and well marked characters peculiar to this species; also, according to Rea (l.c.) the elaters are much longer (over 100 microns) than any other known species of *Battarrea:* the glebal characters, excepting the species just cited, do not give any constant differences for separation of species.

INTERMEDIATE PLANTS

I have a few specimens that are intermediate in some of their characters between *Battarrea laciniata* and *B. phalloides:* one collection, my no. 8177, consists of a loose volva (FIG. 6) and 3 plants having stems, the lower part of the sporocarps and basal volvas but no calyptras; these plants are tall, slender and taper toward base (FIG. 5) and grew in deep sand under Mesquite trees (*Proposis juliflora*). Their· stems are 20 cm., 26 cm.·and 28 cm. tall, by 1–1½ cm. thick at top with a few rough scales, outer volvas are broken off at their tops, whitish, fragile and very brittle with context creamy white, these outer volvas are similar to those of our ordinary *Battarrea phalloides;* their inner volvas consist ·of very thin leaflets, some 6–7 in number with lacerate tops, these leaflets are 3–4 cm. tall and at base of stipe are several short layers of thin leaflets. These plants have the shape, habitat· and outer volvas of *B. phalloides* but the inner volvas as in *B. laciniata*, being in this respect intermediate between the 2 species.

Another collection, no. 9950, consists of 1 old plant which grew in sand at base of a *Yucca*. This plant·is stout with a flattened stem some 20 cm. tall by 2½ × 5 cm. thick, the outer volva and calyptra gone, the inner volva prominent with 2 tough, hard, outer leaflets and inside of these are 6 thinner and taller ones (up to 7 cm. high). This plant resembles the California and Las Cruces

FIGS. 4–6. *Battarrea phalloides*, intermediate forms, × ⁵⁄₇.

plants in its stoutness and in the leaflets of the inner volva and possibly should be called *Battarrea laciniata*. Then I have 33 collections of our common *B. phalloides* consisting of 93 plants, of this number 24 have the outer volvas, 20 the inner volvas and 28 have calyptras. All the outer volvas are whitish, fragile and easily broken in handling, while only 7 have inner volvas with a few leaflets each (FIG. 4).[8] These 7 plants might be called intermediate as far as the inner volvas are concerned but otherwise they are typical *B. phalloides*. All of my *B. phalloides* collections, except the plant shown in figure 4, grew in very poor sandy soil under Mesquite, Pinon or Juniper trees; these plants average slenderer and less robust (FIG. 4–5) than *B. laciniata* (FIG. 1–3).

The plants of our common *Battarrea phalloides* lose their volvas at an early age by rotting hence the number of plants in my collections (69 out of 93) which are without volvas, while my California plants of *B. laciniata* have a much larger proportion of volvas, due to their toughness and to the fact that they were collected only 10–15 days after elongation hence before much rotting could occur.

The calyptra, as used in this paper, consists of two different structures, the shed top of the endoperidium and the attached top of the outer volva which usually does not cover the entire top of the endoperidium; this volva top is firmly cemented to the endoperidium by a thin layer of mucilage about ½ mm. thick. On the elongation of the stipe the outer volva splits along the margin of the cemented portion of the volva where it joins the equatorial volva band, thus leaving the reddish, more or less scaly top of the volva on the endoperidium as a part of the calyptra. The remainder of the outer volva is left at the base of the stipe and consists of the whitish basal portion and the equatorial band of horny texture around the top of the volva cup. The volva cap easily separates from endoperidium when placed in nearly boiling water for 30 minutes.

The main differences between *Battarrea phalloides* and *B. laciniata* are the habitat and the volva of the latter. The complex

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[8] Figure 4 was made from a plant which grew in an open, unshaded area on top of an irrigation ditch bank in a rich sandy acequia soil taken from the bottom of the ditch.

character of the volva, having a tough outer coat with 3 distinct zones, the top zone often having a red cartilagenous structure not seen in any other species, and an inner volva very complex with many layers of thin leaflets, however a few leaflets of the inner volva are occasionally found in *B. phalloides* (FIGS. 4–6).

One outstanding character of *B. laciniata* is the manner in which the leaflets of the inner volva are arranged. There are numerous concentric layers of these leaflets, the outer layer short, then they become successively longer as they approach the stem. Such an arrangement has not been seen in the specimens of *B. phalloides* in my collection, except in the plant found under the *Yucca;* although all of them apparently had an inner bulb- or cup-like volva much like that shown by Lloyd (1906) in his plate 74, figure 2 and by Maublanc & Melançon (1930) in their plate IV and plate V, figures 1 and 3 for *Battarrea Guicciardiniana;* apparently this species does not have an inner volva with leaflets as none are shown in any illustrations of this species.

SUMMARY

I believe that the discovery of many plants in California agreeing in all essential characters with the type of *Battarrea laciniata* and having a similar habitat adds weight to the contention that *B. laciniata* is a valid species. This species grows in rich loamy soil in open unshaded desert areas while our *B. phalloides* is usually found in deep sand in shade of trees: this difference in habitat coupled with the marked characters of the entire volva, would be considered sufficient by many taxonomists to hold *B. laciniata* valid; however there are some intermediate plants with characters common to the two species that make me hesitate to call *B. laciniata* valid, especially when I consider such polymorphic species as *Podaxon pistillaris, Dictyocephalos attenuatus* and *Mycenastrum corium.*

BIBLIOGRAPHY

Lloyd, C. G.   1906.   Myc. Writ. 2 (Tylostomeae): 5–7.
Maublanc, A. & Malençon, G.   1930.   Recherces sur le *Battarrea Guic-ciardiniana*.   Bull. Soc. Myc. France **46**: 43–73.
Rea, Paul Marshall.   1942.   Fungi of Southern California I.   Mycologia **34**: 563–574.
White, V. S.   1901.   The Tylostomaceae of North America.   Bull. Torrey Club **28**: 439–440.

ALBUQUERQUE,
    NEW MEXICO

CYTOLOGY OF VARIOUS BASIDIAL TYPES IN THE GENUS SEPTOBASIDIUM [1]

LINDSAY S. OLIVE

(WITH 3 FIGURES)

INTRODUCTION

In 1938, Couch (1) showed in his monograph on the genus *Septobasidium* that there were at least nine basidial types, from a morphological standpoint, in the genus. Since very little cytological work (Kühner, 4; Couch, 1) has been done on these different basidial types, it seemed of interest to take up such a study.

The six species of *Septobasidium,* showing six different methods of basidial formation, were collected a number of years ago by Professor John N. Couch for the purpose of cytological study. They were recently turned over to the author for investigation and the present paper is the result. There are a number of variations of these six important types discussed, and some of these will be mentioned at the appropriate places.

MATERIALS AND METHODS

The following methods for obtaining good material of *Septobasidium* with germinating basidia were obligingly written for the author by Professor Couch:

"During the rainy season in the tropics and during wet weather in April and May in the north temperate zone, germinating probasidia, basidia, and spores, may sometimes be found in sufficient quantity to preserve for cytological purposes without any special treatment. But for abundant first-class material, specimens of the fungus should be cut off during the sporulating season with some of the bark and then soaked in water for about 30 minutes. After this the excess moisture is drained off with filter paper and the material is placed, with hymenial surface inverted over a slide, in

a damp chamber. Van Tieghem rings make a good support for the material.

"After 12–24 hours a collection of spores on the slide will mean that the basidia are being produced. Material left too long in the damp chamber may become too crowded with basidia. A bit of the hymenial surface teased apart on a slide for examination under the microscope will indicate if the material is at the right stage for preservation. The fungus, with a thin section of the bark, is now cut into 2 mm. cubes and dropped into the killing fluid. If formal-acetic-alcohol is used, penetration is very rapid, and the blocks of fungal tissue sink immediately to the bottom. With chrom-acetic acid penetration may be impeded by air bubbles between the hyphal threads, but these can be removed by shaking the vial or by gently teasing the material with a scalpel."

Of the six species of *Septobasidium* investigated, formal-acetic-alcohol was used as a killing and fixing agent for three of them; namely, *S. alveolatum* Couch, *S. jamaicaense* Burt, and *S. septo-basidioides* (P. Henn.) Lloyd. Flemming's weaker solution was used with the three other species, *S. apiculatum* Couch, *S. sinuosum* Couch, and *S. grandisporum* Couch. Sections were cut on the microtome and varied in thickness, according to the texture of the hymenium. For example, sections of *S. sinuosum,* which has very small basidia, were cut at about 3–5 μ, while those having larger basidia were cut at 7–9 μ. It is interesting to note that most of the fungus material had been imbedded in paraffin 10 to 15 years before being sectioned, and that all material was still in very good condition.

Heidenhain's iron alum hematoxylin staining technique was used throughout and proved satisfactory in every case. The various species will be listed and discussed individually in the following paragraphs. Information on the occurrence, macroscopic appearance, and related species of each type discussed has been taken from the monograph of Couch (1) on the genus.

INVESTIGATIONS

SEPTOBASIDIUM ALVEOLATUM Couch.

This species is reported from Jamaica on *Cinchona* and on *Psychotria* and other deciduous trees. It forms irregular patches

on the bark of living trees.   The context is alveolate and almost black, with small scattered or anastomosing patches of grayish hyphae.   The hymenium contains large probasidia with slightly thickened walls, and these produce 4-celled, curved basidia.   Couch (1) reports 90 species of *Septobasidium* with 4-celled basidia and persisting probasidial cell.   He has placed these in two groups, on the basis of whether the basidium is coiled or whether it is straight.   From a cytological standpoint they appear to fall into a single group.

The probasidium begins as a binucleate outgrowth from a cell of the binucleate mycelium (FIG. 1:1).   These two nuclei become very much larger than the nuclei in the vegetative hyphae.   Chromatin strands and a distinct nucleolus may be observed in each. As the probasidium approaches maturity in size, the two nuclei fuse (FIG. 1:2, 3).   Later only one nucleolus is found in the fusion nucleus and this indicates that a nucleolar fusion has occurred.

When the probasidium starts germinating, the fusion nucleus begins to divide (FIG. 1: 4–9).   A spindle is formed before the nucleus leaves the probasidium, and a number of small chromosomes can be seen on the spindle fibers.   When viewed from a favorable angle, the nucleolus is seen to be attached to the spindle, or more likely to chromosomes on the spindle (FIG. 1: 4).   Moreover, the nucleolus usually appears at this time not to be a spherical body, but a curved or even coiled rod-like body (FIG. 1: 4, 6, 7). There is no evidence that the nucleolus is discharged into the cytoplasm or that it degenerates.   It is believed, however, that the nucleolus divides regularly during meiosis.   This phenomenon will be seen to occur in other species discussed later in this paper.

The first meiotic division results in a 2-celled. basidium, the cross wall being laid down while spindle fibers are still visible (FIG. 1: 10, 11).   A nucleolus can be seen in each of the two nuclei. In the meantime, the probasidial cell has completely emptied its protoplasmic contents into the basidium.   The latter remains attached to the empty probasidial cell, but is cut off from it by a cross wall.

A second meiotic division in each of the two cells results in a 4-celled basidium, each cell of which contains a single haploid
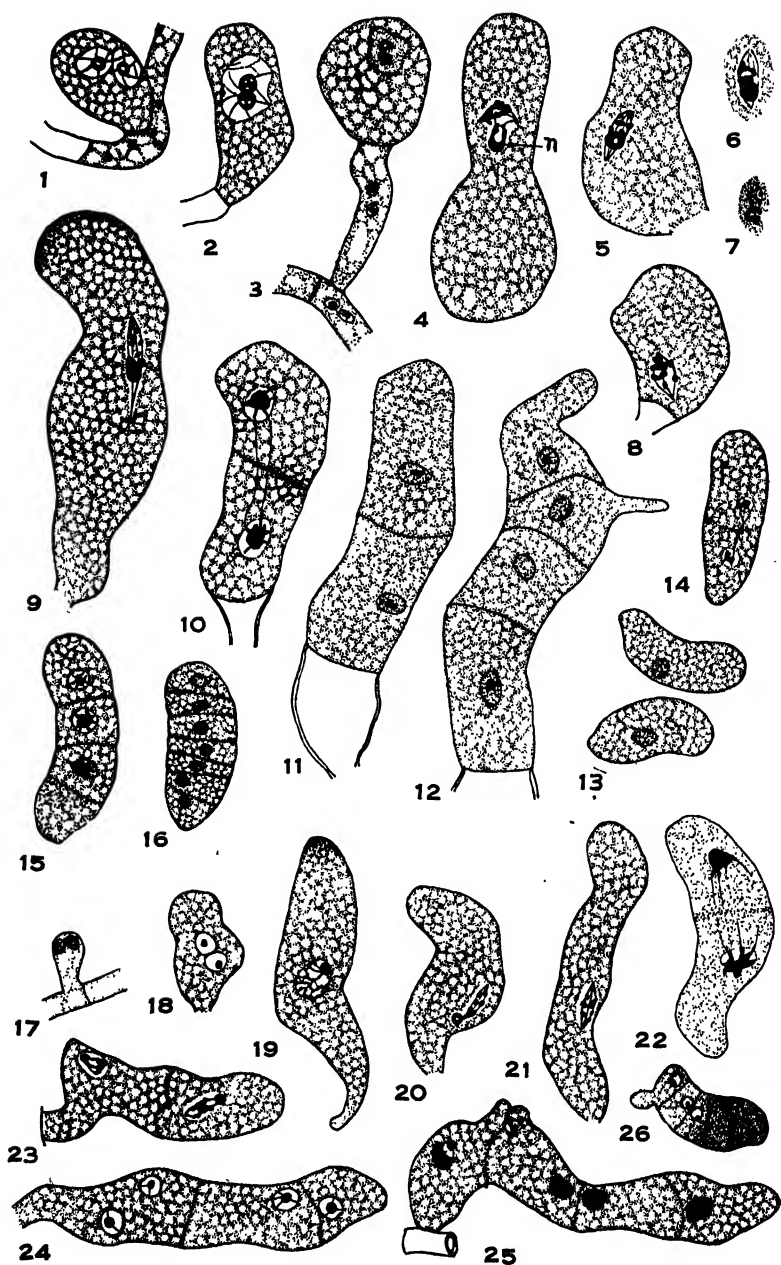
FIG. 1: 1–16, *Septobasidium alveolatum;* 17–26, *S. septobasidioides.*

nucleus with a distinct nucleolus (FIG. 1: 12). This basidium resembles remarkably the basidium of a typical rust fungus, as has been generally recognized by students of this group. Each cell produces a sterigma at the tip of which a basidiospore is formed. The basidiospore receives the entire protoplasmic contents of the cell. Although the spore is shed in the uninucleate condition (FIG. 1: 13), nuclear divisions soon occur within and the spore becomes 2–7-celled (FIG. 1: 14–16).

SEPTOBASIDIUM SEPTOBASIDIOIDES (P. Henn.) Lloyd.

This species occurs in northwest Brazil and Jamaica on species of *Psychotria,* vines, and one of the Sapindaceae. It is described as having a deep brown subiculum and context, with smooth, light buff hymenium.

The type of basidium found in this species does not differ cytologically in any important respect from the type of basidium discussed in the foregoing species. There is, however, no thick-walled probasidium formed here. A binucleate outgrowth from a binucleate cell of the mycelium grows directly into a mature basidium (FIG. 1: 17–25). The two nuclei fuse, as in the foregoing species, to form a single large fusion nucleus with a conspicuous nucleolus and chromatin network (FIG. 1: 19). This nucleus soon divides and a cross wall begins to appear during telophase while the spindle fibers are still visible (FIG. 1: 20–22). The division results in a 2-celled basidium. There is another nuclear division in each cell to complete the reduction division (FIG. 1: 23), and a 4-celled basidium is produced (FIG. 1: 24, 25). During both divisions distinct spindles with small chromosomes may be observed.

Basidiospores may eventually become multi-septate with a single nucleus in each cell. Figure 1: 26 shows a 6-celled basidiospore, one cell of which is giving rise to a bud cell. Couch (1) has indicated that the basidiospores of most species of *Septobasidium* brought into the laboratory will show this budding phenomenon.

There are 25 species of *Septobasidium* reported to have 4-celled basidia and no persisting probasidial cell. These fall under two morphological types according to Couch (1), 15 with coiled basidia and 10 with straight or slightly bent basidia.

SEPTOBASIDIUM APICULATUM Couch.

Here is a unique species reported from the Southeastern United States on species of *Cornus, Hicoria, Quercus, Liquidambar, Magnolia,* and *Cydonia.* It is described as being resupinate with small upright fascicles of hyphae and forming rather small circular or irregular patches on living bark; typically sordid white in color.

Here, again, there is no persisting probasidial cell. A binucleate outgrowth appears either terminally or laterally on a hypha, the cells of which are also binucleate (FIG. 2: 1, 2). As the young probasidium continues to enlarge, the two nuclei fuse in the usual manner and a single fusion nucleus results (FIG. 2: 3–6). Shortly thereafter this nucleus begins its first meiotic division (FIG. 2: 7–10). The spindle is definitely intranuclear in origin and appears before the nuclear membrane is completely broken down. Small chromosomes are visible and the nucleolus can often be seen attached by very small strands either to the spindle or to chromosomes, probably to the latter. This nuclear division may be followed directly by the formation of a cross wall (FIG. 2: 11), or the second meiotic division may begin or even be completed before cross walls are formed (FIG. 2: 12, 13).

The final product is a three-celled basidium (FIG. 2: 14–17). Two of the cells contain one nucleus each, while one of the cells must necessarily contain two nuclei. Commonly the basal cell is binucleate, less frequently it is the middle or terminal cell which has two nuclei (FIG. 2: 15–17). Figure 2: 14 shows a three-celled basidium with one of the nuclei undergoing a delayed second meiotic division in the terminal cell; whereas, in figure 2: 15, this division is occurring in the basal cell. In cases where both nuclei divide simultaneously and before any cross walls appear, it is even more a matter of chance as to which cell becomes binucleate (FIG. 2: 12, 13).

In rare instances a four-celled basidium is found (FIG. 2: 18). This is not surprising, however, as one would be inclined to admit, after observing the type of nuclear divisions which occur here, that the 3-celled basidium must have had its phylogenetic origin in the 4-celled type. The basidia in this species are very small, and apparently the greatest advantage in cutting down on the
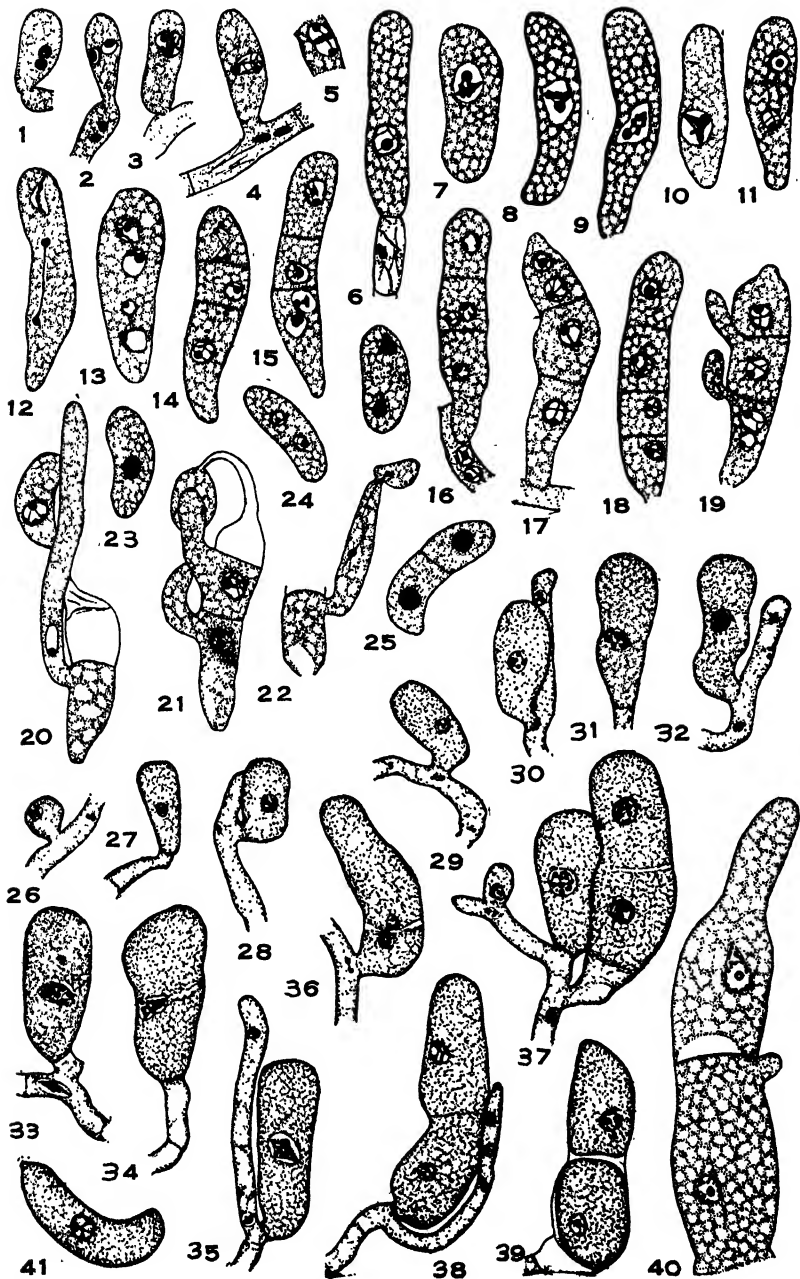
FIG. 2: 1–25, *Septobasidium apiculatum*; 26–40, *S. jamaicaense*.

number of basidial cells is to increase the amount of protoplasm going to each sporidium.

The basidium produces three long, upright sterigmata, each of which produces a basidiospore at its tip (FIG. 2: 19–22). It may be observed at the same time that one of the nuclei in the binucleate cell is becoming smaller. It is believed that this nucleus eventually degenerates completely. At first the basidiospore is uninucleate (FIG. 2: 20, 23), but eventually a nuclear division occurs in the spore so that it becomes binucleate (FIG. 2: 24). A cross wall may sometimes be laid down between the two nuclei (FIG. 2: 25).

This is the only species of *Septobasidium* so far reported which has a 3-celled basidium and no persisting probasidial cell. There are two variable species, however, which may be allied with this form. These are *S. canescens*, which may have a 3- or 4-celled basidium, and *S. Linderi* which is found to have basidia with 2, 3, and 4 cells. Both have a persisting probasidial cell.

SEPTOBASIDIUM JAMAICAENSE Burt.

This fungus has been reported from Jamaica mostly on *Solanum punctatum*. It forms an extensive, thick growth on living bark and has a dark brown mycelium, with grayish, slate-colored hymenial surface.

No persisting probasidial cell is found in this species. The cells of the hyphae contain one to several nuclei (Couch, 1). Only one haploid nucleus enters the young probasidial cell (FIG. 2: 26–30), and, therefore, there is no nuclear fusion in this species. The single nucleus enlarges somewhat after entering, and, as the probasidium increases in size, passes into prophase, during which a number of small thickened chromosomes appear (FIG. 2: 31–34). The metaphase spindle is formed entirely within the disintegrating nuclear membrane (FIG. 2: 35). As nuclear division continues, a cross wall is laid down between the two new nuclei of division (FIG. 2: 36–39). Each nucleus now passes into a brief resting stage and no further divisions occur in the 2-celled basidium. Each cell produces a sterigma (FIG. 2: 40), and a basidiospore is formed at the tip of each. The basidiospore is at first uninucleate (FIG. 2: 41), but Couch (1) has shown that it may later become multi-septate, presumably with a nucleus in each cell.

There are seven species of *Septobasidium* reported to have a 2-celled basidium and no persisting probasidial cell. It is interesting to note that all of these species occur in the western hemisphere and most of them in the tropical areas.

SEPTOBASIDIUM SINUOSUM Couch.

Septobasidium sinuosum has been reported from the southeast section of the United States on a rather wide variety of woody plants, but most abundantly on *Quercus nigra* and *Liquidambar styraciflua*. It is described as being very variable in color, varying from almost white to purplish brown. The fungus occurs on the living bark and its surface is divided by anastomosing sinuous ridges.

The mycelium in this species is also binucleate, and the young probasidium is likewise binucleate (FIG. 3: 1–3). Nuclear fusion soon occurs, so that a single fusion nucleus appears in the probasidium (FIG. 3: 4, 5). Shortly afterwards the wall of the probasidium thickens (FIG. 3: 9). The probasidium later germinates to produce a small basidium, and the nuclear spindle begins to appear before the nucleus passes up into the developing basidium (FIG. 3: 9–11). Very small chromosomes may be seen on the spindle. At first, the nucleolus appears to become double in nature (FIG. 3: 9n), but cannot be followed further during nuclear division. The dividing nucleus, along with all the cytoplasm, passes into the probasidium, and there nuclear division is completed (FIG. 3: 12–15). A cross wall is laid down between the two nuclei, which now pass into a resting phase (FIG. 3: 16). The basidium can be seen attached to its empty probasidial cell.

Each cell of the basidium produces a long, upright sterigma, at the tip of which a uninucleate basidiospore is formed (FIG. 3: 18. 20, 21). After the spore is shed its nucleus divides and a binucleate basidiospore is the result. Occasionally a cross wall appears between the two nuclei, making the spore 2-celled (FIG. 3: 22–24). Undoubtedly this nuclear division in the basiodiospore is the second meiotic division which would be expected to occur in the basidium, but which was delayed up to this point. This type of basidium reminds one of the type found in *Herpobasidium filicinum*, as described by Jackson (3). In that fungus, nuclear fusion is fol-
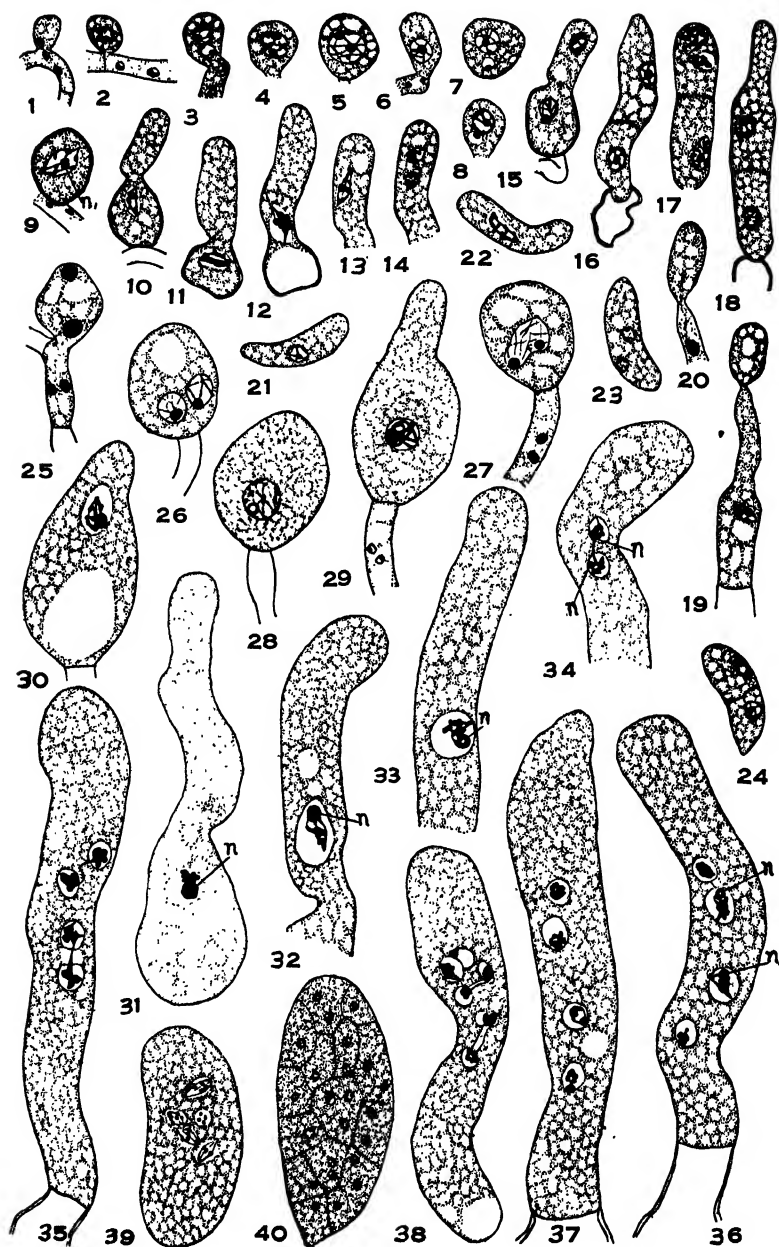
Fig. 3: 1–24, *Septobasidium sinuosum;* 25–40, *S. grandisporum.*

lowed by the production of a 2-celled, binucleate basidium. Jackson did not observe a second nuclear division in the basidiospore, but believes that it is delayed until this spore germinates to produce an infection hypha.

Occasionally, interesting variations in the procedure described above may be observed. Sometimes only one nucleus appears to enter the probasidium (FIG. 3: 6). At other times one of the two nuclei in the probasidium seems to disintegrate (FIG. 3: 7, 8). In such cases, it is obvious that a second nuclear division is not necessary. In some instances, the nucleus in a basidial cell may begin to divide before it passes into the basidiospore (FIG. 3: 17, 19). Although such irregularities are not very common, they are undoubtedly indicative of phylogenetic relationships between this and other species of *Septobasidium,* as will be discussed later.

Thirteen species of *Septobasidium* have been reported as having 2-celled basidia and a persisting probasidial cell. Nine of these occur in the western hemisphere and are reported in about the same regions in which the forms with 2-celled basidia without persisting probasidial cells are found.

SEPTOBASIDIUM GRANDISPORUM Couch.

This is a most interesting species reported from near Charleston, South Carolina, only on *Cornus florida.* It is described as forming extensive spongy patches on the living bark, often girdling the trunk. It has a brownish black context and smoke gray hymenium.

The young probasidium is binucleate and arises from a binucleate hypha (FIG. 3: 25, 26). As the probasidium increases in size, a nuclear fusion occurs to produce a single large fusion nucleus with a distinct nucleolus and chromatin network (FIG. 3: 27, 28). As the probasidium begins to germinate the nucleus passes into prophase, during which several distinct chromatin bands appear (FIG. 3: 29). Shortly thereafter an intranuclear spindle appears and several small, but thickened chromosomes can be seen on the fibers (FIG. 3: 30–33). At the same time, the nucleolus becomes double in nature and in some cases can be seen to be attached, probably to chromosomes on the spindle. As the nucleus divides, the nucleo-

lar halves split apart, one half going to each new nucleus (FIG. 3: 34).

The second meiotic division begins directly after the first has been completed and no cross wall is formed in the basidium. These divisions result in a large 4-nucleate basidium, with no cross walls appearing (FIG. 3: 35–37). By this time the probasidium has completely emptied its protoplasmic contents into the basidium and a cross wall separates basidium and probasidium, the latter persisting as an empty supporting cell.

Nucleoli may be seen during the second meiotic division also (FIG. 3: 36, 37). Although they cannot be followed as well during this division, they probably divide in the manner already described for the first meiotic division. It is not clear as to whether the nuclear membranes disintegrate during these divisions, but apparently they do not, as is indicated in most of the figures.

Now the large, one-celled basidium gives rise to a single apical sterigma, which produces at its tip one large basidiospore. The four haploid nuclei in the basidium may begin to divide before passing into the basidiospore (FIG. 3: 38), or they may begin to divide or continue to divide in the spore after the latter is shed (FIG. 3: 39). The final product is a multicellular basidiospore with one or more nuclei in each cell. Couch (1) has shown that these cells may produce bud cells. Apparently the final segregation of characters into separate cells is a function which has now been taken over by the basidiospore.

Only one other species of *Septobasidium* possessing a one-celled basidium has been reported. It also has a persisting probasidial cell and forms a single basidiospore. This is *S. purpureum* Couch, which is reported from Jamaica.

DISCUSSION

The 4-celled basidium with persisting probasidial cell is the typical form for the genus *Septobasidium*. It is also probably the most primitive type. Most of the other forms seem to be merely variations of this, and were probably derived phylogentically from such a form. For example, in *S. apiculatum,* which has 3-celled basidia, the number of cells has been reduced from four to three, possibly to increase the supply of cytoplasm going to each sporid-

ium. The fact that a few 4-celled basidia are found occasionally in the hymenium also indicates that the ancestors of this form had 4-celled basidia.

The failure of more than one nucleus to pass into the probasidium and the lack of nuclear fusion in *S. jamaicaense* may account for the production of basidia with only two cells. No second nuclear division is needed. However, the significance of the lack of nuclear fusion in the life cycle is not clear.

In *S. sinuosum,* where nuclear fusion does occur and 2-celled basidia are formed, the second meiotic division appears to occur in the sporidium after it is shed. The occasional tendency of the nuclei to divide before passing into the basidiospores indicates a phylogenetic relationship to types with 4-celled basidia, in which this second meiotic division normally occurs in the basidium. The basidia in this species are very small and the cutting down on the number of cells would increase the amount of cytoplasm going to each basidiospore, which is probably an advantage to the fungus. The occasional distintegration of one of the two nuclei in the probasidium, so that only a single haploid nucleus remains, is probably indicative of the manner in which forms such as *S. jamaicaense* arose. The fact that the majority of species of *Septobasidium* related to *S. sinuosum* and all those related to *S. jamaicaense* so far reported, occur in the western hemisphere and are intermingled with one another in the same areas, adds further emphasis to this belief.

Such variable species as *S. Linderi,* which may have 2-, 3-, or 4-celled basidia, *S. canescens* with 3- or 4-celled basidia, and *S. Clelandii* with 2- or 4-celled basidia are undoubtedly species which are still in a state of flux and do not yet have any fixed type of basidium.

The 1-celled basidium, as found in *S. grandisporum,* is a unique type which must have resulted from the complete failure of the basidium to form any cross walls after nuclear division. The large multicellular, multi-nucleate basidiospore, which takes over the final segregation of characters into separate cells, is also a very interesting feature of this species.

The nucleolar history during nuclear divisions in the basidia of the various forms is very interesting. There appears to be a nu-

cleolar division simultaneous with nuclear division. First the nucleolus splits into two halves and becomes a double structure. Often during this phase the nucleolus can be seen attached to the spindle, probably to chromosomes on the spindle. Then as the chromosomes pull apart to form the two new nuclei, the halves of the nucleolus separate and pass in opposite directions, one going to each nucleus. The author (5) reported this phenomenon earlier in a study of meiosis in *Coleosporium Helianthi.* Fitzpatrick (2), on the other hand, in an investigation of meiosis in *Eocronartium muscicola,* states that: "The nucleolus persists throughout all stages of mitosis and passes into one of the daughter nuclei in late telophase." Others have reported a disintegration of the nucleolus during meiosis. I have found neither to occur in *Septobasidium,* and indications are that the nucleolus divides at the same time that the chromosomes divide.

The meiotic spindles are quite small in all of the species studied. The clearest spindles indicate that the haploid number of chromosomes in the various species is either 4 or 5, probably 5.

SUMMARY

1. Six species of *Septobasidium* showing six different methods of basidial formation have been cytologically studied with the following results:

a. *S. alveolatum:* binucleate probasidium in which nuclear fusion occurs; 2 meiotic divisions in the basidium; 4-celled basidium; persisting probasidial cell.

b. *S. septobasidioides:* same cytological history as above, but without a persisting probasidial cell.

c. *S. apiculatum:* binucleate probasidium; nuclear fusion; 2 meiotic divisions; 3-celled basidium, one cell of which contains 2 nuclei with one of these nuclei later degenerating; no persisting probasidial cell.

d. *S. jamaicaense:* uninucleate probasidium; no nuclear fusion; one nuclear division to produce a binucleate, 2-celled basidium; no persisting probasidial cell.

e. *S. sinuosum:* binucleate probasidium; nuclear fusion; one meiotic division in the basidium; 2-celled basidium produced; sec-

ond meiotic division usually occurring in the basidiospore; with persisting probasidial cell.

f. *S. grandisporum:* binucleate probasidium; nuclear fusion; 2 meiotic divisions, without cross wall formation; 1-celled basidium, 1 large basidiospore which becomes multi-nucleate and multicellular; with persisting probasidial cell.

2. The nucleolus appears to divide during meiosis, one half passing into each of the new nuclei of division.

3. The chromosome number for the various species, as well as can be determined, is probably 5.

BIBLIOGRAPHY

1. **Couch, J. N.** The genus *Septobasidium.* University of North Carolina Press. 1938.
2. **Fitzpatrick, H. M.** The cytology of *Eocronartium muscicola.* Am. Jour. Bot. **5**: 397–419. 1918.
3. **Jackson, H. S.** The nuclear cycle in *Herpobasidium filicinum* with a discussion of the significance of homothallism in the Basidiomycetes. Mycologia **27**: 553–572. 1935.
4. **Kühner, R.** Contribution à l'étude des Hyménomycètes et spécialement des Agaricacés. Le Botaniste **17**: 17–23. 1926.
5. **Olive, L. S.** Nuclear phenomena involved at meiosis in *Coleosporium helianthi.* Jour. Elisha Mitch. Sci. Soc. **58**: 43–51. 1942.

EXPLANATION OF FIGURES

(All figures × 1220, except Figure 2: 26–39, × 825)

FIG. 1. *Septobasidium alveolatum* (1–16). 1, binucleate probasidium; 2, 3, nuclear fusion in the probasidium; 4, germinating probasidium with nucleus in metaphase showing attached nucleolus (n); 5–9, metaphase nuclei showing the varied appearance of the nucleoli; 10, telophase with cross wall appearing; 11, two-celled basidium with persisting probasidial cell; 12, four-

celled basidium producing sterigmata; 13–16, basidiospores. *S. septobasi-dioides* (17–26). 17, 18, binucleate probasidia; 19, probasidium with fusion nucleus; 20, 21, metaphase of first meiotic division; 22, telophase with cross wall beginning to appear; 23, two-celled stage with nuclei passing into second meiotic division; 24, four-nucleate basidium just before the final cross wall is laid down; 25, four-celled basidium producing sterigmata; 26, multicellular basidiospore with one cell producing a bud cell.

Fig. 2. *S. apiculatum* (1–25). 1, 2, binucleate probasidia; 3–5, nuclear fusion; 6, probasidium with fusion nucleus; 7–10, metaphase of first division, showing attachment of nucleoli in some cases; 11, end of telophase with cross wall having just appeared; 12–15, various methods in which the second meiotic division may occur; 16–19, various types of basidia formed, the last being most common; 20–22, production of basidiospores; 23–25, types of basidiospores observed. *S. jamaicaense* (26–40). 26–30, probasidia showing the entrance of only one nucleus; 31–34, probasidia with nuclei in prophase; 35, metaphase showing distinct chromosomes; 36, telophase with cross wall being formed; 37–39, binucleate stage showing formation of cross wall to produce the two-celled basidium; 40, basidium giving rise to sterigmata; 41, basidiospore.

Fig. 3. *S. sinuosum* (1–24). 1–3, formation of the binucleate probasidium; 4, 5, nuclear fusion in the probasidium; 6, only one nucleus entering the probasidium; 7, 8, one of the two nuclei disintegrating in the probasidium; 9, metaphase spindle appearing, nucleolus (n) double in appearance; 10–13, metaphase spindles passing into the basidia; 14, telophase; 15, binucleate basidium following first meiotic division; 16, two celled basidium showing persisting probasidial cell; 17, second meiotic division occurring in the upper cell of a basidium; 18, two-celled binucleate basidium with one of the cells producing a sterigma; 19, upper basidial cell producing a basidiospore while the nucleus begins to divide as it passes into the sterigma; 20, nucleus passing through sterigma toward the basidiospore; 21, uninucleate basidiospore; 22, second meiotic division in the basidiospore; 23, binucleate basidiospore; 24, two-celled, binucleate basidiospore. *S. grandisporum* (25–40). 25, 26, binucleate probasidia; 27, nuclear fusion in the probasidium; 28, probasidium with fusion nucleus; 29, probasidium germinating with nucleus in prophase; 30, metaphase in the probasidium; 31, 32, beginning of metaphase showing the two-parted nucleolus (n); 33, metaphase in the basidium showing attachment of nucleolus; 34, telophase accompanied by separation of nucleolar halves; 35, second meiotic division; 36, second meiotic division showing nucleoli; 37, one-celled basidium with four nuclei showing conspicuous nucleoli, also showing persisting probasidial cell; 38, nuclear divisions occurring in the basidium after the completion of meiosis; 39, basidiospore with nuclei dividing mitotically; 40, multicellular and multi-nucleate basidiospore.

STUDY OF A NEW TRICHOLOMA

ELIZABETH EATON MORSE

(WITH 11 FIGURES)

A white spored agaric growing in dense clumps from sclerotoid masses has been known to people in the University of California at Berkeley for approximately twenty-five years. Repeated attempts to identify it by means of the available literature failed, and, in the course of time, specimens were submitted to various specialists, namely, Doctors Jacob E. Lange, Carleton Rea, John Dearness and A. H. Smith. With one exception all reported the opinion that it is an undescribed species. Several collections of this same agaric have been made during recent years by A. H. Smith and H. E. Parks in northern California, and D. E. Stuntz and A. H. Smith in the region of Puget Sound, Washington.

My study of this agaric has been greatly facilitated by the cooperation of the specialists mentioned above. Doctor Smith very kindly sent me his notes, specimens and photographs in order that I might compare the material collected in Washington and northern California with our collections from the San Francisco Bay region. Since all clearly apply to the one species under consideration, the following composite descriptions have been compiled:

Tricholoma sclerotoideum [1] sp. nov.

Pileus 1.5–5.5 cm. latus, convexus dein paene planus, margo primo involutus demum saepe revolutus, glaber vel sericeo-fibrillosus, pallido-cinnamomeus, demum sordide alutaceus; caro pallidior, tenuis; lamellae tenues, confertae vel subdistantes, sinuato-adnatae vel subdecurrentes, paucae furcatae, aliquae dimidiatae, irregulares, orae non equales, primo albidae demum sordide alutaceae; stipes 3–5 cm. longus, 5–10 mm. crassus, concolor vel pallidior, sericeus dein obscurior, equalis, vel major base, vel abrupte angustus base, *oriens in densis caespitibus e massa plectenchymata;* hymenium 30–39 μ crassum; basidia prope cylindrica, 4-spora; sporae 6–9.5 × 3–3.5 μ, leves, subfusiformatae, in cumulo albae; cystidia nulla. A. H. S.

[1] Genus determined by J. Dearness, also species name supplied by him; *massa,* a Latin name meaning cheese curd, would be equally appropriate.

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Figs. 1–11. *Tricholoma sclerotoideum.*

Figs. 1–11. *Tricholoma sclerotoideum—Continued.*

Pileus—1.5–5.5 cm. broad, even, dry, convex, becoming nearly plane, margin involute at first, may be upturned at maturity, glabrous to naked eye and with satiny luster, sometimes appressed fibrillose (FIG. 3) ; pale cinnamon buff to cinnamon buff (R), finally sordid pale tan, fresh Berkeley specimens medium tone of gray; flesh pale buff, most fragile; trama of pileus homogeneous.

Lamellae—6 × 20 mm., thin, close to subdistant, ventricose, sinuate-adnate or with a distinct decurrent tooth, sometimes forked or with many lamellulae at margin, whitish at first, later pallid to buff becoming a dingy ocher (wood brown, R), edge often irregular (FIG. 5) ; "sometimes not well formed and then thick or more or less crisped, clearly abnormal" (A. H. S.).

Stipe—3–5 cm. long by 5–10 mm. thick, solid often flattened, paler than the pilei, hoary at first, soon unpolished and sordid, equal or ventricose or narrowed to base, sometimes tapered to a narrow rhizomorph by which it is attached or deeply embedded in the sclerotoid mass (FIG. 4), sometimes attached abruptly on the mass (FIGS. 1, 5) ; produced in dense clusters from the masses.

Spores—smooth, subfusiform, hyaline, whitish in mass, 6–9.5 × 3–3.5 μ, not amyloid.

Basidia—nearly cylindric, four-spored, average length 15–18 μ.

Cystidia—none.

Taste—mild.   Odor—none.

Range.   Coastal regions of Washington and California.

Habitat: Rotting coniferous duff, or "in conifer woods with a moss and humus floor over a glacial outwash mostly ravel; daytime temperature 60°–70° F." (Stuntz).

A typical collection is deposited in Herbarium of University of Michigan as Smith no. 9040.

THE SCLEROTOID MASS

The sclerotoid masses of plectenchyma, up to 8 × 12 cm., lacking definite shape and ectoderm, are covered at the surface with a mixture of mycelium and forest litter.   The tissue within at first is white, solid, of cheesy consistency, pale orange when dried, finally may decay to a blackish, oozy mass.   Clamp connections, but no kind of spores, have been found either in the masses or in the mycelial extensions around them.   Doctor Grace E. Howard reports "no fruiting" in these cheesy growths (letter, Feb. 10, 1936).

Tissue cultures from firm, fresh material were made by Doctor Lee Bonar and studied through a period of eighteen months "without securing growth other than a mass of sterile hyphae." He further states: "The masses appear to function solely in furnishing nutriment to the dense growth of sporophores while the latter are forming. Spores from the gills of fresh material show a low percentage of germination in water after 48 hours." L. B.

Doctors Smith and Stuntz also expressed the view that the "masses" are food organs and not carriers from season to season, or supporters under unfavorable conditions. The mycelium only is perennial. Smith remarked further that quite a few agarics produce somewhat similar soft, fleshy masses of tissue in connection with their sporophores—such as *Psathyrella hirta* and *Clitopilus abortivus*.

The place of the mass in the life cycle of this species is not entirely clear at this time. It is not known just when the soft masses begin to develop, how long a period of time elapses from the initial stages to the mature fruiting bodies of the agaric, whether or not all the masses regularly produce fruiting bodies, or whether many remain sterile.

The seasons north and south vary so much that no months may be named when the different stages of growth may be anticipated. For example, in the Puget Sound region the wet season begins early, late in August or early in September, and the fertile masses are ready to fruit in November, when most of Smith's and Stuntz's collections were made; after that, the weather there becomes cold. However, Smith had collections in May and July (1939), at Lake Crescent, Wash. It thus appears that they had two crops in the north.

In the San Francisco Bay region where our collections were made, the wet season starts much later, in October and November, and continues during the winter months. The masses with us are usually ready to fruit in midwinter, when it has already become cold in the north. The finding of a small mass, 1 cm. in diameter, May 3, 1942, is explained from the fact that our rains continued very late last spring, into early May. This growth is unmistakably an early stage of a mass, showing the tortuous tracery, texture

and color of material masses, no hyphae filled into the chambers (FIG. 6).

Whenever and wherever these masses occur we are safe in averring that they precede the sporophores and that both result from long periods of wet weather.

SUMMARY

PROBABLE LIFE HISTORY

1. Dense clusters of *Tricholoma sclerotoideum* are found in coniferous regions of the Pacific Slope during and after the heavy rains of the wet season.

2. These clusters grow from sclerotoid, cheese-like masses which function as food reservoirs.

3. The ripened sporophores drop their spores which germinate and form mycelium rather promptly, provided the climatic conditions are favorable.

4. The mycelium may hold over during the dry months till the arrival of fall rains, then revive and produce "masses."

5. The masses, full of fertile hyphae, sooner or later, under a favorable combination of warmth and moisture, give rise to the spore bearing bodies, and the life cycle is completed.

HELVELLA LACUNOSA Afzel (*Helvella Mitra* L.) (FIGS. 2, 10, 11)

AN ACCIDENTAL ASSOCIATE

There has been a strong suspicion for some years that the above discomycete, which is often abundant, up to 16 cm. tall (Morse), 20 cm. (Stuntz), with stems 5 cm. wide, and found in the same areas with *Tricholoma sclerotoideum,* might have had some part in the formation of the masses. The following observations are submitted:

1. The *Tricholoma* and *Helvella* may be not only gregarious in the same areas, maturing at the same time, but they may be crowded into the same cluster (FIG. 2).

2. We have no positive evidence that one species is either stimulated or checked by the presence of the other.

3. However, attention is called to the rather depauperate *Helvella* (Berkeley, FIG. 2) as compared with the luxuriant specimens growing on the same hillside.

4. Also, the sporophores of the *Tricholoma* (FIG. 5) are exceptionally large as compared with all other specimens sent to me by any collector.

5. Might the wandering mycelium of the *Helvella* secure elements in the soil by which the *Tricholoma* and its mass are enriched? The possibility of endoparasitism may be referred to some experimenter.

6. The *Helvella* is found repeatedly where there is no *Tricholoma*, hence it appears that there is no obligate relationship between them.

7. No mummified remains of either species have ever been observed—which discounts the theory of parasitization.

Comment: An association between the two species is evident, but the nature of it needs further study.

SPECIMENS COLLECTED

Jan. 1925, in pine forests, Oakland and Berkeley Hills, Bonar and Parks.

Jan. 1928, in a garden under *Pinus,* Oakland, Calif., Morse.

Jan. 1934 and Feb. 1938, on a steep hillside planted to pines, back of Univ. of Calif. Stadium, a grayish variant, Morse.

May 3, 1942, a young "mass," same locality as next above, Morse.

Nov. 10, 1934, in conifer woods, Tacoma Prairies, Wash., no. *259,* D. E. Stuntz.

Dec. 9, 1935, under conifers, Trinidad, Calif., no. *3894,* Parks and Smith.

Nov. 12, 1937, same locality as next above, no. *8666,* Smith.

Nov. 15, 1937, on soil in mixed forest, Siskiyou National Forest, Calif., no. *8749,* Smith.

Nov. 23, 1937, under conifers, Trinidad, no. *9040*-type, Smith.

Nov. 29, 1937, on soil, Siskiyou National Forest, no. *9221,* Smith.

May 29, 1939, under madroña trees, Lake Crescent, Wash, no. *13839,* Smith.

July 6, 1939, under conifers, Joyce, Wash., no. *14839,* Smith.

Oct. 26, 1941, Tenino Junction, Tacoma Prairies, no. *1194,* Stuntz and Smith.

Oct. 31, 1941, under brush, Port Ludlow, Wash., no. *17839,* Smith.

Nov. 9, 1941, Deception Pass, Wash., no. *1204,* Stuntz.

April 5, 1943, under pines, back of Stadium, Berkeley, Bonar.

It appears from the above that all collections have been made during months of the rainy season, except in rare cases of late rainfall.

COMPARISON WITH PREVIOUSLY DESCRIBED SPECIES

There are several species which appear to have some characters in common with *Tricholoma sclerotoideum,* such as *Clitocybe connata* Schum. According to Ricken this is the same as *Tricholoma connatum,* the spores of which fit in Smith's lower bracket—6–7 × 2–3 μ. There is no mention, however, of any basal fungous growth.

Clitocybe opaca (With.) Fries grows caespitose, connate at base, but it is described as entirely white and no basal growth is mentioned. Spores 6 × 4 μ.

Tricholoma unifactum Peck has been proposed, but this is a whitish fungus, with white hymenium and globose spores.

Tricholoma albellum Fries is a large, fleshy, whitish fungus which becomes grayish, but it has no basal growth. Spores 5–6 × 3 μ.

Smith informs me that in 1941, in the vicinity of McKenzie Pass, Oregon, he found a *Tricholoma* obviously closely related to *T. sclerotoideum* by the characters of the sporophores, but distinct by its smaller spores and lack of basal growth. His study of this fungus has not yet been completed.

The new Tricholoma has no known closely related species.

additional localities, also opinions on *Helvella lacunosa* as an associate.

CALIFORNIA MYCOLOGICAL SOCIETY,
UNIVERSITY OF CALIFORNIA,
BERKELEY, CALIFORNIA

EXPLANATION OF FIGURES

FIG. 1, photograph by A. H. Smith, figs. 2–11 by W. C. Matthews. *Tricholoma sclerotoideum* Morse: (1) sporophores at different stages, pilei with margins inrolled to flattened or even slightly upturned; lamellae adnexed, some forking, lamellulae at margin; stipes separate, fairly equal, attached to fungous masses which show externally hyphal threads mixed with forest litter, internally, an alternation of tortuous tracery and white mycelium; (2) a compact cluster of sporophores up to 30 fully matured, showing stages of development, produced from and attached to a vegetative mass, 12 cm. wide. This mass was separated from an extensive growth in the rotting coniferous duff. A small specimen of *Helvella lacunosa* Afz. is crowded in this cluster; (3) young sporophores, pilei glabrous to slightly floccose, showing attachment at top of mass; stipes with enlarged bases; (4) a cluster of young sporophores laterally attached, showing margins inrolled, stipes ventricose, elongated, ending in narrow rhizomorphs deeply embedded in the mass; (5) fully mature sporophores with wavy, upturned margins, showing eroded edges of lamellae, many lamellulae, and equal, flattened stipes; (6) early stage of mass, sectioned, hygrophanous, fragile, chambered, mycelium not yet grown in (Berkeley, May 3, 1942, after belated rain); (7) an older mass, vertically sectioned, solid, firm, mycelium grown in; (8) an older mass, cheese-like, in rotting pine needles; (9) no ectoderm, the mass and hyphal strands spreading out into the coniferous duff; (10) an average specimen of *Helvella lacunosa* has enlarged base resembling, externally, a mass; (11) a larger base, broken into pieces, shows only solidified soil and mycelium, no plectenchyma.

Note: The Helvellas are introduced to serve as a guide when searching for the new *Tricholoma*.

NOTES AND BRIEF ARTICLES

Aquatic Phycomycetes [1]

The first noteworthy studies on aquatic fungi were made over 100 years ago and the chief groups of the Phycomycetes had already been outlined before 1900. Before this latter date was reached they had been studied by such well known botanists as de Bary, Braun, Cornu, Dangeard, Fischer, Schenck, Thaxter, de Wildeman and Zopf. In the last 25 years these organisms, especially those included in the Chytridiales, in the older usage of this name, have become the objects of renewed extensive study. This intensity of interest is shown by the fact that of the 708 titles in the Bibliography of the book under review half date from 1917 to the present. The author himself is responsible for 34 of these, so that it was with first-hand knowledge of his subject that he began, quite a number of years ago, to assemble all the past studies on the aquatic Phycomycetes to produce a book in which all the species described in the past 100 years may be found, with original descriptions improved where possible in the light of the more recent studies. Where there is no doubt species are reduced to synonyms but in cases where recent work has not cleared up the status of an older species it is included with its original description. The manuscript was completed two years before this book was published, February 20, 1943, and was in editorial hands in close coöperation with the author until the final page proof was corrected. To care for species described and important papers published in this·two year interval foot-note references have been added.

The limitation of the work to aquatic organisms has caused omissions that prevent it from being a complete manual for all the orders and families of the Phycomycetes, even with·a broad interpretation of the term aquatic. Any one of these fungi that is parasitic or saprophytic upon submerged portions of aquatic plants

or animals is included but species growing on land plants or animals are omitted. Thus the genus *Synchytrium* is not included while *Micromyces* and *Micromycopsis* which attack algae are given full discussion. In the genera *Olpidium* and *Plasmodiophora* the species that attack the roots of land plants (*e.g. O. Viciae, P. Brassicae,* etc.) are conspicuous by their absence from the systematic discussion but those that attack aquatic plants are included in the keys and among the described species. In the Peronosporales only the Family Pythiaceae is included and then only the aquatic species. The Mucorales and Entomophthorales, not being aquatic, are not considered.

Two main lines of development are recognized, those orders and families which produce posteriorly uniflagellate zoöspores and those that produce anteriorly (or laterally) biflagellate zoöspores. The first series includes Chytridiales, in a restricted sense, Blastocladiales and Monoblepharidales, considered as a phylogenetically progressive line. The second series includes the Plasmodiophorales, Saprolegniales, Leptomitales, and Peronosporales. The Hyphochytriaceae with zoöspores anteriorly uniflagellate are considered to be "of uncertain affinities."

The Chytridiales are divided into an inoperculate series with seven families and an operculate series with two families. In each series the families are arranged progressively from monocentric to polycentric forms. The Physodermataceae in the inoperculate series are not included since they are parasitic only upon land plants. The reader will be surprised at the spelling *Rhizophydium* instead of the more customary *Rhizophidium,* but this in accordance with the original spelling of the name by Schenck and is not a *lapsus calami*. The omission of *Pseudolpidiopsis* from the Olpidiaceae, for *Olpidium*-like fungi with conjugation within the host filament in the manner of *Olpidiopsis* is explained by the identification of species described by Cornu, Zopf and Fisher as possessing posteriorly uniflagellate zoöspores, with commonly occurring species of *Olpidiopsis* which have two anterior or lateral flagella, on the assumption that the observations of the earlier authors on flagellum number and position were erroneous. In the reviewer's opinion it is a little dangerous to conclude that three such skilled mycologists actually erred in this manner, especially in view

of the recently proved existence of parallel uniflagellate and biflagellate forms in *Rozella* and *Rozellopsis,* respectively. Further study, moreover, seems to be indicated as necessary to determine whether forms like *Olpidiomorpha* and *Sphaerita,* described with zoöspores possessing a single anteriorly attached but posteriorly trailing flagellum, should be placed, as the author does, in the Olpidiaceae or in the Hyphochytriaceae.

The Plasmodiophorales are included in the biflagellate series of Phycomycetes instead of in proximity to the Myxomycetes, the position more usually assigned to this order by earlier writers. The author includes *Woronina* in this order and not in the Olpidiopsidaceae. Other fungi formerly placed in the Chytridiales, in the broader use of the term, are *Ectrogella* and *Thraustochytrium,* here placed in the Saprolegniales, and the Olpidiopsidaceae and Sirolpidiopsidaceae placed in the Lagenidiales (Ancylistidales). In the Pythiaceae only *Pythiogeton, Zoophagus* and *Pythiomorpha* are given consideration, *Pythium* being omitted because of the monograph by Miss Matthews and *Phytophthora* which is not usually aquatic unless *Pythiomorpha* is an aquatic form of that genus as suggested by some British Mycologists.

The List of Substrata should prove very useful to mycologists who are interested in the Phycomycetes. The hosts are arranged systematically by major groups and alphabetically in each group. The extensive Bibliography is a mine of information. The citations are not abbreviated beyond recognition as is too often the case. The make-up of the book is admirable, and the appearance of the pages is pleasing. The reviewer has found no typographical errors. The 69 figures contain many smaller figures, making a total of 634. In some cases they are original drawings but they are mostly carefully executed redrawings of the original illustrations of various authors. With relatively few exceptions every genus is illustrated and in genera where species represent a wide range of morphological differentiation the most important types are shown.—ERNST A. BESSEY.

THE STARTING POINT FOR NOMENCLATURE OF THE FUNGI

There is considerable divergence of opinion among mycologists concerning the interpretation of Article 19, f, of the International

Code, which is now apparently leading toward an increased confusion in the use of names. This section states, "Fungi caeteri, 1821–1832 (Fries, Systema Mycologicum)." The latter work then is the starting point for all fungi, except the *Uredinales, Ustilaginales* and *Gasteromycetes,* which begin with the Persoon, *Synopsis Methodica Fungorum.*

Some mycologists, including the writer, have considered the entire series of the *Systema* to be the starting point for *Ascomycetes, Phycomycetes,* and *Basidiomycetes* other than the above, with the exact point of departure for any one species being the page and date in the *Systema* in which it was first published. This has always seemed logical, because if otherwise why should both the Brussels and Cambridge Congresses cite the dates of the entire series, 1821–1932.

The other point of view is that only the date of the first volume of the *Systema,* 1821, should be the starting point, and a motion to this effect has been placed before the last International Congress by C. W. Dodge.[1] Then Donald Robers[2] thinks this will clarify mycological literature. He also shows evidence that Gray's *Natural Arrangements* of *British Plants* (1821) is later than the first volume of the *Systema.*

Seymour, in his *Host Index of Fungi of North America,* has considered Gray's *Natural Arrangement* to be later than the Fries *Systema.* Then he says, "In practice Persoon's *Mycologia Europaea,* 1822–1828, must be considered as the date of departure for some groups published in the later volumes of Fries, according to our interpretation of the rules." He is apparently considering only the first date of the *Systema* rather than the whole series.

Ramsbottom[3] says in regard to this point, "One view is that the work and not the date is the important point, and that each group of fungi treated in the *Systema* has its starting point at the date it appeared there." He further thinks this view is more logical than using the date 1821 as the starting point, but says the latter may be more expedient.

[1] Mo. Bot. Gard. Ann. **21**: 709–710. 1934.
[2] Mycologia **33**: 568–570. 1941.
[3] Trans. Brit. Myc. Soc. **25**: 438. 1942.

The writer has examined many current monographs and lists of both American and European origin, and it is impossible to escape the fact that most mycologists, neither in the present nor in the past, have ever conformed to a code. On the other hand it would be difficult to find a taxonomic flora published since the second edition of *Gray's Manual* in 1908 which even mentions pre-Linnaean names, or authorities. In mycology, however, we still find more authors writing *Hypoxylon coccineum* Bull., than that use *H. fragiforme* (Pers. ex Fr.) Kickx, the specific name found in the *Systema*. So neither the American nor the International Codes have secured much uniformity of names in the past, and to now start with the date 1821, rather than the date of the particular fungus, would result in greatly increasing the confusion, especially with the *Ascomycetes*. If adopted this would make all *Discomycetes* as well as *Pyrenomycetes* with names in the second volume of the *Systema* (1822–1923) post-Friesian, and would validate present synonyms in the Schweinitz *Synopsis Carolinae* (1822), Gray's *Natural Arrangements,* and others.

Method of Citing the Authority for the Specific Name

Recommendation XXV ter permits one to cite an author before the starting point by the use of brakets, or with the expression *ex.* The example is *Boletus piperatus* [Bull.] Fr., or *B. piperatus* Bull. ex Fr. The use of parentheses is reserved for the changes of valid names. There are also different interpretations of this rule.

The writer has been using the *ex* in this manner—*Xylaria Hypoxylon* (L. ex Fr.) Grev. The only advantage in indicating the pre-Friesian author is the added precision in determinations. However, this is not done by taxonomists of the higher plants, and it certainly does add to the length of the name.

Another source of confusion is found when the author responsible for the description later changes the species to another genus. One can follow the rule literally as Nannfeldt[4] and Lundell in the following example:

407. CORTINARIUS TRAGANUS (Fr. ex Fr.) Fr. Epicr. p. 281. 1835.
   Agaricus traganus Fr. Obs. Myc. 2: 82. 1818.
   Agaricus traganus Fr. Syst. Myc. 1: 217. 1821.

[4] Fungi Exsicc. Suecici. Praes. Upsal. fasc. IX–X. 1937.

Bisby [5] also repeats the author under similar circumstances, as *Dichaena faginea* (Fr.) Fr.

Seymour, in the *Index,* apparently makes his own rules when citing a pre-Friesian name as *Boletus cinnabarinus* Jacq. ex Fr. when there is no change in the genus, and *Polyporus cinnabarinus* (Jacq.) ex Fr. to indicate a change. On the other hand when Fries is responsible for both the description and the change he writes *Hypoxylon multiforme* Fr. leaving off the last Fries.

The writer also has not repeated the author as it seems less confusing. However, it would be better to write *Hypoxylon multiforme* (Fr.) Fr., and *H. rubiginosum* (Pers. ex Fr.) Fr., than to follow Seymour with *H. rubiginosum* (Pers.) ex Fr. and *Peniophora velutina* (DC. ex Fr.) Cooke for a case where the changing author was a different person. Placing Persoon's name in parenthesis certainly does not clarify the situation.

Various methods of citation are used in the *List of Common Names of British Plant Diseases.*[6] There is *Dilophospora Alopecuri* (Fr.) Fr. and *Epichloe typhina* (Fr.) Tul., apparently leaving out the pre-Friesian author, and in the same paper there is *Nectria cinnabarina* (Tode) Fr. and *Plowrightia ribesia* (Pers.) Sacc. The last two pre-Friesian names are used as though they were written after the *Systema.*

Sydow [7] in the *Mycotheca Germanica* (1938) not only uses the pre-Friesian name in parenthesis, but in most cases leaves off the combining authority, as when he writes *Epichloe typhina* (Pers.). The zoölogists have this usage, but it seems desirable to cite the other author so students can discover the reasons for the change.

Choice of Specific Names in the Systema

If we start with the *Systema,* according to the wording of the rule, then the logical procedure is to accept the name recognized by Fries in this work. For example, Fries uses *Cenangium ferruginosum* Fr. and cites as a synonym *Peziza Abietis* Pers.

[5] Trans. Brit. Myc. Soc. **25**: 135. 1941.

[6] List of Common Names of British Plant Diseases. Cambridge Univ. Press. 75 pp. 1934.

[7] Mycoth. Germ. fasc. LXI–LXIV. Ann. Myc. **36**: 318–319. 1938.

Seymour confuses this apparently simple application by stating, "Under *Cenangium ferruginosum* Fr., S. M. 2: 187, the earlier name *Peziza Abietis* P. occurs as a synonym. This is a valid name because its identity is here recognized by Fries, and on this basis it is chosen by Rehm and should be written *Cenangium Abietis* (P. ex Fr.) Rehm." Then in later pages of the *Index* he further confuses the issue by writing under four different species of pine one of the following:

Cenangium Abietis (Pers. ex Fr.) Rehm
Cenangium Abietis (P.) ex Duby
Cenangium Abietis Pers.
Cenangium ferruginosum Fr.

Fries often lists many synonyms, and if the modern mycologist had to go back and look up all of these for purposes of priority, in addition to the impossible job of locating types for these names, the confusion would be greatly increased. If this idea was carried to a logical conclusion the entire purpose of the Code would be defeated.

Many American mycologists copy their names from Seymour's *Index,* and with his great diversity under different hosts, one wonders which name they usually accept. He has not always started with names recognized by Fries.

Another cause for confusion exists when Fries has two or more names in the *Systema* for the same fungus, and in such cases a literal application of priority would result in the selection of the one written first. For example Wehmeyer [8] has recently changed a name long in use, *Aglaospora profusa* (Fr.) Ces. & De Not. to *A. anomia* (Fr.) Lamb. The latter species is on page 381 and the former on page 392.

In conclusion, names are as necessary in the fungi as in the higher plants. Uniformity and permanency are of great importance especially in the applied fields, and while this goal is laudable it can never be achieved except in a very limited manner. Conservation of specific names with authors would result in complete stagnation in the field of mycology. Early mycologists with a

[8] A.Revision of *Melanconis, Pseudovalsa, Prosthecium* and *Titania*. Univ. Mich. Press. 161 pp. 1941.

background of poor morphological or cultural studies usually lumped many forms together that we now recognize as having different relationships. The modern more critical studies often necessitate combining or splitting so-called species or moving them to other genera, and this usually results in the dropping of old and the creation of new names. This type of diversity cannot be stopped, but the other kind of diversity due to differences of interpretation of rules or refusal to accept them can be remedied by some more general agreement ·among mycologists and probably some compromises.—JULIAN H. MILLER

A POSSIBLE REPRINTING OF SACCARDO'S SYLLOGE FUNGORUM

The Alien Property Custodian has recently announced (Science 97: 303–4. 1943) that many technical books and sets of books of Axis origin are available for republication. The procedure to be followed in obtaining necessary licenses and other details is given and it is clear that every encouragement will be given to bring about prompt reproduction of books of this kind.

To mycologists and plant pathologists this announcement immediately suggests the possibility of the reproduction of Saccardo's classical *Sylloge Fungorum* in usable form. This compendium of mycological descriptions is a "sine qua non" and the comparatively few sets now in use in the Americas are showing the effect of much use. Additional copies have been practically non-existent heretofore, only occasional sets appearing on the market at rare intervals and at exorbitant prices. There are undoubtedly many institutions as well as individual mycologists and plant pathologists who will welcome an opportunity to purchase a set of Saccardo, and doubtless even those libraries now possessing the work will desire an additional set to relieve the wear and tear on the original.

It has been ascertained that a satisfactory reproduction of the 25 volumes can be produced. If 100 subscriptions are obtained by November 1, the complete set of 25 volumes can be obtained at $200.00 per set; if 300 subscriptions are obtained, the price will be $150.00 per set. These prices are based on an offset edition, with the type block photographically reduced ten per cent.

In order that the undersigned may obtain an idea of the number

of prospective purchasers, interested mycologists are requested to send in tentative subscriptions and to interest their respective institutions in doing likewise.—JOHN A. STEVENSON, *Bureau of Plant Industry, Soils and Agricultural Engineering, Beltsville, Maryland.*

AN INTRODUCTION TO INDUSTRIAL MYCOLOGY

A second edition of the above work by George Smith has recently appeared.   This volume deals largely with those fungi which are commonly known as moulds, not so much from the standpoint of classification but rather from their economic bearing and use in the industries.   To a taxonomist it might seem a little confused for the author treats the Ascomycetes in one chapter, in another the yeasts, and in two quite remote and extensive chapters the Aspergilli and Penicillia, without giving us any suggestion as to the natural relationship.   However, this is probably excusable in a work of this kind.

The book is illustrated almost entirely with photomicrographs. The volume will be found very useful to. those interested in the economic phases of mycology.—F. J. SEAVER.

THE BOLETACEAE OF NORTH CAROLINA

Under this title there has just been issued by W. C. Coker and A. H. Beers from the University of North Carolina Press a 96 page book entirely in keeping with others of that helpful series on such other groups as the Saproleginaceae, Clavariaceae, the Gasteromycetes, *Septobasidium,* and *Pythium,* all by or under the stimulating direction of the senior author of the present volume.   After a very brief historical introduction the authors go immediately into the taxonomic treatment, taking up in sequence the genera *Boletus, Boletinus,* and *Strobilomyces,* as those genera have been so long recognized.   The genus *Boletus* contains 68 species and 6 varieties, which, due to the location of the state and the variation in altitude, are mainly the species that would be met in any part of the eastern United States and Canada.   These are keyed out in a type of key that, to some workers at least, will be found less confusing than some of the keys in previous volumes from this laboratory.   In fact, two keys are presented—a practice that has much

to commend it. Then follow complete descriptions that are the result of about forty years acquaintance and observation (on the part of the senior author) with these plants. Here, as throughout the book, no attention is paid to International Rules of Nomenclature, species being assigned to their original author regardless of dates. As a result, the names used are those under which the plants have always been known. Also, little attention is devoted to European synonymy—all practices that have much in their favor. The distribution within the state is given by citing localities, and it is noteworthy that collections in adjoining states are also cited. There are included also citations to illustrations in the literature and comparative notes with other species. In *Boletinus* are included but four species and in *Strobilomyces* but one.

Twenty of the species are illustrated in color and most of the others by photographs produced in half-tone. Perhaps these photographs are not quite up to the standards set in other works from this laboratory, but the colored plates (6 in number) are well executed. Microscopic details, mostly dealing only with spores, are all excellently done in five plates of lines drawings. The reviewer has always felt that no one has yet demonstrated that there are not specific differences in microscopic details of other characters than spores in this family. It is also rather surprising to note the authors' conclusion with reference to the change in color of the flesh, when exposed, that "This color is variable in its intensity and even in its presence in plants of the same species at times and should not be made a major basis for specific distinction." On the other hand emphasis is placed on stem reticulation, and of the two it was always the reviewer's opinion that the former was the more reliable and constant. No clue is given as to what idea the authors had in mind in the sequence of the specific descriptions, so that, after using the key, it becomes necessary to look up each species in the index in order to find the location of its description. This could have been avoided by numbering the descriptions and inserting that number, along with the name, in the key.

The book is nicely bound and retails for $7.00, which may appear somewhat excessive; nevertheless it will be found indispensable for any individual who is making any serious attempt to identify boletes.—L. O. OVERHOLTS.

Dr. W. C. Coker, with the assistance of Alma H. Beers, has added another to his list of valuable and attractive publications on the Fungi of North Carolina. This time it is a book on the boletes of the state containing descriptions of 73 species and 6 varieties, illustrated by many colored and halftone plates. A supplementary key based primarily on color provides a convenient check. North Carolina is a meeting-place for northern and southern species, which accounts for the large number collected. The low coastal plain should yield still other species if the fungus flora of Florida is any criterion.

Three new species are published, *B. parvulus, B. subfraternus* and *B. viridiflavus*. The last suggests *B. auriporus* Peck, although perfectly distinct. For such a conservative treatment, the authors perhaps strain a point in keeping a plant like *B. separans* Peck specifically distinct from *B. edulis* Bull. The *B. communis* complex, also, seems to be treated rather liberally. Herbarium workers would be relieved of a lot of unnecessary trouble if there were an alphabetical list of species with the names of their authors. Such a list requires very little space, and no work of this kind is complete without it. Why should one first have to consult the index to get the page and *then* turn to the page to get the author?

Dr. Coker is to be complimented for waiting forty years before publishing this work, during which time he was gathering valuable notes and illustrations. The halftones do not *appear* so striking as in some of his other publications, but the colors of boletes make them difficult to photograph. Fortunately, what is lacking in the halftones is often supplied by the colored plates. Unfortunately, Dr. Coker did not learn much about genera in those forty years. Nor about Latin diagnoses. Or was it because he just didn't give a hang!—WM. A. MURRILL.

The publication of "The Boletaceae of North Carolina" by Dr. W. C. Coker and Alma Holland Beers brings to mind recollections of three most pleasant seasons spent in the mountains of western North Carolina many years ago. In company with Dr. W. A. Murrill I received a welcome introduction to the study of the Boletaceae and in his company enjoyed the finding of three or four very distinctive new species. It is scarcely a flaw in the work by

Coker and Beers to point out that *Ceriomyces Atkinsonianus, C. subpallidus* and *C. Housei* described by Dr. Murrill have been previously transferred to *Boletus* by Saccardo and Trotter in the Sylloge Fung. Suppl. **8**: 236, 245, and 248 respectively in 1912. The excellent illustrations and descriptive text supply us with a most valuable reference work on the Boleti of the southern Appalachian region.   For the small but distinct new species which the authors describe as *Boletus parvulus,* I would substitute the name **Boletus Cokeri** nom. nov. (*B. parvulus* Coker & Beers, Boletaceae of North Carolina, p. 69. *pl. 46 & pl. 64. f. 7.* 1943, not *Boletus parvulus* Massee, Bull. Miscell. Bot. Gard. Kew p. 204.   1909). Massee's species is from near Singapore, Asia, and is said to be related to *B. spadiceus* Schaeff. of Europe.—H. D. HOUSE.

SOME NEW OR RARE FLORIDA DISCOMYCETES AND HYSTERIALES

EDITH K. CASH

(WITH 6 FIGURES)

Extensive collections of fungi made in Florida during the years 1937 to 1943 by Dr. C. L. Shear include about three hundred specimens of Discomycetes and Hysteriales which the writer has had the opportunity of examining. Several of these appear to be undescribed and are named as new in this account; notes are also given on four other species which are unreported or rare in the United States. The specimens have been deposited in the Mycological Collections of the Bureau of Plant Industry, and where the material was in sufficient quantity to divide, portions have been also sent to the herbaria of the New York Botanical Garden, the University of Michigan, and to the Farlow Herbarium of Harvard University.

The writer gratefully acknowledges the receipt of type specimens from Drs. David H. Linder and W. L. White of the Farlow Herbarium and Dr. H. M. Fitzpatrick of Cornell University. References to some of the fungi here discussed were also supplied through the kindness of Dr. White.

1. Lophium Tillandsiae sp. nov.

Ascomata superficial, sparse, flabelliform, laterally compressed and narrowed toward the base, fuscous to fuscous black,[1] slightly

[1] Color nomenclature throughout is that of Ridgway, R., Color standards and color nomenclature. Washington, 1912.

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paler above, 0.3–0.5 mm. high, 0.2–0.3 mm. wide, 0.1 mm. thick, opening by a slit along the top, minutely roughened and sometimes faintly transversely striate; asci terete, the wall thickened at the apex, short-pedicellate, 8-spored, 250–300 × 10–12 μ; ascospores nearly the length of the ascus, 2.5–3 μ thick, hyaline or subhyaline, parallel, multiseptate, spore sections oblong, 1-guttulate, 4–5 μ long; paraphyses filiform, irregularly branched, pale brownish.

Ascomata superficialia, sparsa, flabelliformia, lateraliter compressa et basim versus attenuata, nigro-fusca, 0.3–0.5 mm. alta, 0.2–0.3 mm. lata, 0.1 mm. crassa, rima apicali aperientia, minute asperula, interdum transverse striata; asci teretes, apice crasse tunicati, breve stipitati, octospori, 250–300 μ longi, 10–12 μ lati; ascosporae longitudinem asci subaequantes, 2.5–3 μ crassae, hyalinae vel subhyalinae, multiseptatae, paralleles, articulis oblongis, uniguttulatis, 4–5 μ longis; paraphyses filiformes, irregulariter ramosae, pallide fuscidulae.

On *Tillandsia fasciculata*, Mar. 3–4, 1941, C. L. Shear *1386* and *1387* and on *Tillandsia* sp., Mar. 1, 1937, *725 (Type)*, all from Highlands Hammock, near Sebring.

L. Tillandsiae differs in shape from other species of *Lophium* having apothecia less than 1 mm. in height, also from *L. schizosporum* Maire in the absence of a black subiculum, and in shorter asci.

Few fungi have been found reported on *Tillandsia;* therefore the presence of various other fungi on these specimens may be worth mention, although none is in sufficient quantity or in good enough condition for a specific identification: *Lophodermium* sp., *Tryblidaria* sp., *Orbilia* sp., *Phragmonaevia* sp. and *Stictis* sp.

2. **Propolidium salmoneum** sp. nov.

Apothecia densely gregarious, slightly beneath the surface, opening by irregular lobes which remain to form a lacerate margin around the hymenium, 1–2 × 1 mm. elliptical or oblong; hymenium pale ochraceous salmon to salmon buff, white-pruinose; asci broad-cylindrical, with the wall conspicuously thickened at the apex, short-pedicellate, 8-spored, 55–65 × 9–10 μ; ascospores cylindrical, straight or slightly curved, slightly narrowed and rounded at the ends, irregularly 2–3-seriate, 3–7-septate, 15–26 × 3–4 μ; paraphyses filiform, branched near the tips and subcircinate; hypothecial layer hyaline, plectenchymatic, 10–20 μ thick.

Apothecia dense gregaria, subimmersa, elliptica vel oblonga, 1–2 mm. longa, 1 mm. lata; hymenium ochraceo-salmoneum, albo-pruinosum, epidermide fissa

lobata cinctum; asci late cylindrici, pariete ad apicem valde incrassato, breve pedicellati, octospori, 55–65 μ longi, 9–10 μ lati; ascosporae cylindricae, rectae vel subcurvatae, utrinque leniter attenuatae, 2–3-seriatae, 3–7-septatae, 15–26 μ longae, 3–4 μ latae; paraphyses filiformes, ad apices ramosae et subcircinatae; hypothecium hyalinum, plectenchymaticum, 10–20 μ crassum.

On decorticated wood, Clermont, Mar. 6, 1942, C. L. Shear *1388.*

P. salmoneum is strikingly similar in general appearance to *Propolis faginea* [Schrad.] ex Karst., from which it may readily be distinguished by the small asci and narrow, septate spores.   The interpretation by different authors of the genera of the Stictidaceae having elongate, septate spores varies greatly, and keys to these genera are difficult to follow.   The fungus in question appears to agree most nearly with *Propolidium* Sacc. (not Rehm), with the exception of the several-septate spores.   In the type species, *P. glaucum* (Ellis) Sacc., the spores are uniseptate; however Saccardo later included in *Propolidium* species having spores with several septa; this broader conception of the genus would, therefore, allow the species to be included here.

3. Cryptodiscus Sambuci sp. nov. (FIG. 2)

Apothecia elliptical-fusoid, 0.5–1 × 0.2–0.5 mm., scattered or gregarious in whitened areas of decorticated wood, deeply immersed and only partially emerging between the fibers, with no well-defined exciple, the swollen host tissue forming a raised margin; hymenium flesh colored to flesh ocher; asci cylindrical-clavate, gradually narrowed toward the base, the wall thickened and rounded at the apex, 8-spored, 65–75 × 6–8 μ; ascospores irregularly 2–3-seriate, hyaline, cylindrical-fusoid, 5–7-septate, 15–20 × 3–3.5 μ; paraphyses filiform, hyaline, simple or branched, slightly thickened at the tips; hypothecium hyaline, thin, plectenchymatic; entire hymenium colored pale blue with iodine.

Apothecia elliptico-fusoidea, 0.5–1 mm. longa, 0.2–0.5 mm. lata, sparsa vel gregaria, in ligno decorticato dealbato profunde immersa, inter fibras submergentia; hymenium carneo-ochraceum, ligno tumido prominente cinctum; asci cylindrico-clavati, basim versus gradatim attenuati, apice crasse tunicati, octospori, 65–75 μ longi, 6–8 μ lati; ascosporae irregulariter 2–3-seriatae, hyalinae, cylindrico-fusoideae, 5–7-septatae, 15–20 μ longae, 3–3.5 μ latae; paraphyses filiformes, hyalinae, simplices vel ramosae, apice leniter incrassatae; hypothecium hyalinum, tenue, plectenchymaticum; hymenium totum jodi ope pallide azurescens.
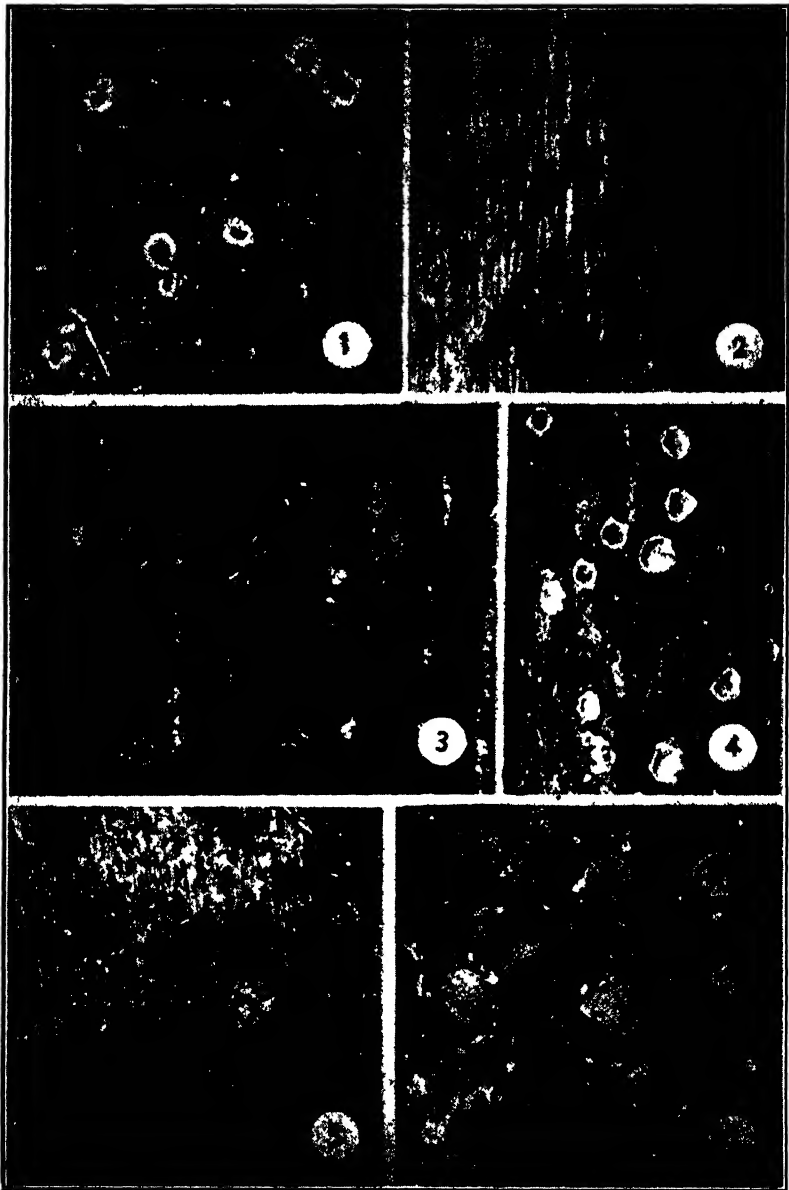
Fig. 1, *Dasyscyphella subcorticalis* on *Xanthoxylon fagara* (× 14); 2, *Cryptodiscus Sambuci* on *Sambucus* sp. (× 8); 3, *Nemacyclus culmigenus* on *Panicum* (× 9); 4, *Stictis Sagaretiae* on *Sagaretia minutiflora* (× 8); 5 and 6, *Corynella atrovirens* on *Sambucus* sp. (× 7).

On decorticated stems of *Sambucus* sp., Winter Park, Feb. 8, 1940, Feb. 16 and Feb. 17, 1941, C. L. Shear *1389 (Type)*, *1390* and *1391*.

Superficially the fungus resembles *Cryptodiscus pallidus* (Pers. ex Fries) Corda, but differs in the longer, narrower, 5–7-septate spores.

4. Nemacyclus culmigenus Ellis & Langl. (FIG. 3)

On *Panicum* sp., Vero, Dec. 18, 1938, C. L. Shear *1392*; on *Andropogon* sp., Winter Park, Feb. 18 and 19, 1941, and Jan. 29, 1942, *1393, 1394*, and *1395*.

These Florida specimens have been compared with the type collection (Langlois *1443*) from the Langlois herbarium in the Mycological Collections of the Bureau of Plant Industry. *N. culmigenus* was described (1, p. 151) on *Panicum proliferum*, but is apparently not confined to this host genus, since apothecia found on *Andropogon* do not seem to differ essentially from those on *Panicum*. The fungus has also been collected recently on *Andropogon scoparius* at Athens, Georgia, by Dr. J. H. Miller. The elongate fruiting bodies opening by a slit or lobes to expose the greenish-pruinose hymenium, and the short asci distinguish the species from the other Stictidaceae occurring on grasses.

5. Stictis Serenoae sp. nov.

Apothecia sparse, orbicular, 0.2–0.6 mm. in diameter, the epidermal covering at first raised in a hemispherical dome, then splitting in three-to five lobes which turn back and form a dentate border around the marguerite yellow, pruinose hymenium; asci cylindrical, narrowed at the base and apex, 8-spored, 55–65 × 5–8 μ; spores parallel, filiform, straight, hyaline, multiguttulate, 50 × 1–1.5 μ; paraphyses filiform, hyaline, unbranched, slightly enlarged and yellowish at the tips, coalescing to a form a subhyaline epithecium.

Apothecia sparsa, orbicularia, immersa, 0.2–0.6 mm. in diam., primum epidermide hemisphaericaliter elevata tecta, dein erumpentia et eaque stellatim fissa cincta; hymenium flavidum, pruinosum; asci cylindrici, basim apicemque versus attenuati, octospori, 55–65 μ longi, 5–8 μ lati; ascosporae filiformes, paralleles, rectae, multiguttulatae, hyalinae, 50 μ longae, 1–1.5 μ latae; paraphyses filiformes, hyalinae, simplices, ad apicem flavidulae et leniter inflatae, epithecium formantes.

On leaves of *Serenoa serrulata*, Winter Park, Jan. 9, 1941, C. L. Shear *1396 (Type)*, Jan. 3, 1942, Jan. 22, 1943, and Feb. 3, 1943, *1397, 1398* and *1399*.

6. Stictis Sagaretiae sp. nov. (FIG. 4)

Apothecia sparse or densely gregarious, immersed, orbicular, 0.5–1 mm. in diameter, margin thin, entire or lobate, white; hymenium wood brown to buffy brown, drying dark olive buff; asci cylindrical-fusoid, abruptly narrowed at the base and apex, 8-spored, 65–80 × 7–11 μ; ascospores hyaline, parallel, multiseptate, 55–65 × 3–4 μ, strongly helicoid after leaving the ascus; paraphyses numerous, closely septate, simple or branched near the apex, 1 μ in diameter; hymenium staining blue with iodine.

Apothecia sparsa vel gregaria, immersa, orbicularia, 0.5–1 mm. diam., margine tenui, integro vel lobato, albo; hymenium ex avellaneo olivaceum; asci cylindrico-fusoidei, ad apicem et basim abrupte attenuati, octospori, 65–80 μ longi, 7–11 μ lati; ascosporae hyalinae, dense septatae, ex ascis valde helicoideae, 55–65 μ longae, 3–4 μ latae; paraphyses numerosae, simplices vel ramosae, 1 μ in diam.

On twigs of *Sagaretia minutiflora*, Highlands Hammock, Feb. 3, 1937, C. L. Shear *433 (Type)*, and Feb. 22, 1937, *791*.

S. Sagaretiae appears to be similar in some respects to *S. elegans* Grelet which differs, according to the description (*2*, p. 206), in the fimbriate margin and pale hymenium. *S. Puiggarii* Speg. has longer asci and spores. No specimens of either of these two species have been examined.

7. Schizoxylon Betheli (Ellis & Ev.) comb. nov.

Agyriella Betheli Ellis & Ev. Bull. Torrey Club 24: 470. 1897.
Agyriopsis Betheli (Ellis & Ev.) Sacc. & Syd., Sacc. Syll. Fung. 14: 805. 1899.

On twigs of *Abrus precatorius*, Avon Park, Jan. 19, 1937, C. L. Shear *77* and *79*.

The type specimen of *Agyriella Betheli* Ellis & Ev. in the Bethel Collection of the Division of Forestry Pathology is on *Bigelovia graveolens* collected at Ft. Garland, Colorado, E. Bethel *340-A*. The fungus was originally described as having hyaline paraphyses, sparingly branched and not noticeably thickened; however examination of Bethel's *340-A* shows that in mature apothecia the para-

physes are swollen, branched and greenish-brown at the tips. Four-spored and more rarely two-spored asci were found in the Florida specimens. The spores break up in the ascus into segments 3–5 μ long. Since the essential characters agree with those of *Schizoxylon* it seems advisable to transfer the species to that genus. *Schizoxylon dermateoides* Rehm is a similar fungus, which was thought from the description (6, p. 336) might possibly be identical. However, examination of type material from the Fairman Collection in the Cornell Herbarium sent by Dr. H. M. Fitzpatrick demonstrated that *S. dermateoides* has larger apothecia and much longer asci with acute apices, and can scarcely be considered the same species.

8. **Dasyscyphella subcorticalis** (Pat.) comb. nov. (FIG. 1)

> *Erinella subcorticalis* Pat. in Duss Énum. Méth. Champ. Guadeloupe, p. 67. 1903.

On dead stems of *Xanthoxylon fagara*, Mar. 8, 1937, C. L. Shear *893*; on *Persea* sp. (?), Feb. 22, 1937, *811*, and on unknown host, March 4, 1941, *1400*, all at Highlands Hammock; on dead stems, Royal Palm Park, Dec. 15, 1938, *1401*, and Castellow Hammock, Mar. 16, 1942, *1402*.

Patouillard's fungus was described from Guadeloupe, and has not previously been reported from the United States, so far as the writer has been able to find. Through the courtesy of Drs. D. H. Linder and W. L. White, opportunity was afforded to compare the Florida collections with one of Patouillard's original specimens, *509*, and they were found to agree perfectly in all microscopic details. In the original description the hymenium is said to be golden yellow ("jaune d'or"), while the Ridgway color readings of the Florida specimens range from pinkish-buff to orange cinnamon. Since, however, hymenium color is known to vary under different conditions, this slight discrepancy is not regarded as of sufficient importance to separate the Florida collections from Patouillard's species, particularly in view of their complete agreement in other respects.

If *Dasyscyphella* is maintained as distinct from *Erinella*, the filiform paraphyses of *E. subcorticalis* would place it in the former genus.

9. Corynella atrovirens (Pers. ex Fries) Boud. (FIG. 5–6).

On decorticated wood of *Sambucus* sp., Winter Park, Dec. 5, 1938, C. L. Shear *1403*.

Although reported by Schweinitz and Curtis from North Carolina and by Cooke and Ellis from New Jersey, this species appears to have been collected only rarely in the United States, the only fairly recent record being that by Kauffman (*3*, p. 216) from Michigan.[2] It may well, however, have been listed under some different name that has escaped notice, since it has been placed in nearly a dozen genera in several families of the Discomycetes. Nannfeldt (4, p. 194, 199, 203) has added several names to its synonymy.

The Florida specimen agrees with Phillips Elvellacei Britannici *141*, issued as *Calloria atrovirens*, and with the descriptions given by European authors. The young apothecia in Dr. Shear's collection are densely furfuraceous, sometimes nearly covered by a mass of fine yellowish-green hyphae. When moist the hymenium is olivaceous, becoming reddish-brown on drying. The primary spores are subfusoid, straight or curved, multiseptate, $15–16 \times 2–3 \mu$, the secondary spores curved, $2 \times 1 \mu$.

10. Leciographa floridana sp. nov.

Apothecia single or in groups of two or three, erumpent from cracks in the bark, subsessile, corky to carbonaceous, brittle when dry, patellate, convex when moist, 0.7–1.2 mm. in diameter; hymenium natal brown to clove brown, slightly roughened by protruding asci; margin smooth, narrow, blackish brown; asci cylindrical-clavate, entire wall staining deep blue with iodine, gradually narrowed toward the base, wall thickened at the apex, 8-spored, $90–110 \times 18–20 \mu$; ascospores fusoid, brown, irregularly 2-3-seriate, 7-9-septate, $35–41 \times 8–9 \mu$, the end cells subhyaline; paraphyses filiform, much branched, thickened and brown at the tips, interwoven to form a thick, brownish epithecium; hypothecium pale brown, prosenchymatic, intermediate layer $50–100 \mu$ thick, composed of thin-walled, subglobose or angular cells $10–15 \mu$ in diam.; cortex a dense brown pseudoparenchyma, made up of cells $7–9 \mu$ in diam.

Apothecia solitaria vel gregaria, ex rimis corticis erumpentia, subsessilia, patelliformia, suberosa vel carbonacea, 0.7–1.2 mm. diam.; hymenium rufo-

[2] For these and other references, the writer is indebted to Dr. W. L. White.

brunneum, margine glabro, angusto, atro-brunneo circumdatum; asci cylin-drico-clavati, basim versus gradatim attenuati, ad apicem crasse tunicati, jodi ope intense coerulescentes, octospori, 90–110 μ longi, 18–20 μ lati; ascosporae late fusoideae, brunneae, irregulariter 2–3-seriatae, 7–9-septatae, 35–41 μ lon-gae, 8–9 μ latae, cellulis ultimis subhyalinis; paraphyses filiformes, multira-mosae, ad apices incrassatae, intertextae et epithecium crassum brunneum formantes; hypothecium fuscidulum, prosenchymaticum; stratum intermedium 50–100 μ crassum, e cellulis tenuibus subglobosis vel angularibus 10–15 μ in diam. compositum; stratum corticale densum, brunneum, pseudoparenchy-maticum.

On dead, partly decorticated branches of *Liquidambar styraci-flua*, Longwood, Jan. 2, 1941, C. L. Shear *1404*.

The large fusoid spores, abruptly narrowed at the ends and with hyaline or subhyaline tips, are the most characteristic feature of this fungus.   Similar spores are present in *Patellaria calliospora* Penz. & Sacc. described from Java, which may possibly be identi-cal.   No specimens are available for comparison, but judging from the description and illustration (5, p. 90, *pl. 60, fig. 2*) the species from Java differs in thicker spores.

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LITERATURE CITED

1. **Ellis, J. B. & Everhart, B. M.**   New species of fungi from various localities. Proc. Acad. Nat. Sci. Phila. **1893**: 128–172.   1893.
2. **Grelet, L. J.**   Discomycètes nouveaux (2ᵉ série).   Bull. Soc. Myc. France **42**: 203–207.   *pl. 8*.   1927.
3. **Kauffman, C. H.**   Unreported Michigan fungi for 1910, with outline keys of the common genera of Basidiomycetes and Ascomycetes.   Mich. Acad. Sci. Rept. **13**: 215–249.   1911.
4. **Nannfeldt, J. A.**   Notes on type specimens of British inoperculate Discomy-cetes.   (First part, Notes 1–50.)   Trans. Brit. Myc. Soc. **20**: 191–206. 1936.
5. **Penzig, O. & Saccardo, P. A.**   Icones fungorum javanicorum.   124 pp., *80 pl*.   1904.
6. **Rehm, H.**   Ascomycetes novi.   Ann. Myc. **4**: 336–341.   1906.

A NEW SPECIES OF CLAVICEPS ON CAREX [1]

J. WALTON GROVES [2]

(WITH 2 FIGURES)

The occurrence of a species of *Claviceps* in the ovaries of *Carex stellulata* var. *angustata* Carey (= *C. angustior* Mack.) was reported by Groh (**1911**). He did not give the species a name as the perithecial stage was not observed, but he illustrated the sclerotia as they occur on the host and suggested that it might be close to *Claviceps nigricans* Tul. occurring on species of *Eleocharis* and *Scirpus*.

Subsequent collections of this ergot were received by the Division of Botany and Plant Pathology from Quebec in 1934, 1935, 1939, and from Anticosti Island in 1936. In all of these collections the sclerotia were found to be almost entirely destroyed by the larvae of an insect. Lepage (**1938**) reported the insect *Acylomus ergoti* Csy. on ergots of *Carex*, said to be *Claviceps caricina* Griffiths.

C. caricina was described by Griffiths (**1902**) and distributed in Griffiths' West American Fungi *400*. Examination of this specimen disclosed sclerotia very different from those of Groh's collection, and occurring in the culms, not in the ovaries. Groh stated that *C. caricina* Griff. was the fungus known as *Sclerotium sulcatum* Desm. and this was confirmed by Whetzel (**1929**). The latter demonstrated that *S. sulcatum* was the sclerotial stage of a *Sclerotinia* and included both *S. sulcatum* and *C. caricina* as synonyms of *Sclerotinia Duriaeana* (Tul.) Rehm. It is, therefore, evident that the identification of Lepage's fungus as *C. caricina* is a misdetermination, since he obviously had a true ergot and undoubtedly the same species as that described in this paper.

In 1939 Mr. Groh again collected this ergot on *Carex* near Milner, B. C. and sent a large collection for examination. Most

of these sclerotia were also infested with the insect larvae, but on going over the material carefully a number of sound sclerotia were found. These were placed on moist sand in a culture dish and put in a refrigerator at 0° C. on Aug. 5, 1939. On Nov. 10, 1939 they were removed from the refrigerator and transferred to the greenhouse. The temperature in the greenhouse varied from 4°–15° C. and the dishes were shaded from direct sunlight.

The first evidence of the development of perithecial stromata was observed on Dec. 26, 1939. The stroma was at first rounded, fleshy, colorless, about 0.5–1.0 mm. in diameter, soon becoming pinkish, "salmon color" to "buff pink" (Ridgway), very similar in color to the common *Tubercularia vulgaris* Tode. These pinkish heads increased in diameter and became raised on blackish-violet stalks. In about three weeks the ostioles of the perithecia were visible as darker orange dots on the head, but mature asco-spores were not found until Jan. 26, 1940, a full month after the first appearance of the stromata.

It was thought that inoculation experiments might give some clue as to the identity of this fungus. The only material available at the time the perithecia were mature was some wheat plants growing in pots in the greenhouse. Some of the heads in which anthers were showing were inoculated with an ascospore suspension in sterile water, but the results were negative. This result is not regarded as positive proof of the inability of the *Carex* ergot to infect wheat flowers.

Brefeld (1891) and others have shown that conidia of *Claviceps purpurea* (Fries) Tul. are readily produced in culture. Accordingly ascospore cultures of this fungus were made with the hope of obtaining conidia for use in further inoculation experiments. Unfortunately these cultures were killed shortly afterwards by a sulphur dioxide leak in the low temperature chamber in which they were stored.

The ascospores germinated readily and gave good mycelial growth on potato dextrose agar. The colonies were white, rather slow-growing, more or less convoluted and with little aerial mycelium. They were somewhat similar in appearance to the cultures of *C. purpurea* illustrated by Bonns (1922, *pl. XVI, fig. 3*). Up to the time they were lost they had not developed any color.

As noted above, it was suggested by Groh (1911) that this species might be close to *Claviceps nigricans* Tul. occurring on *Elocharis* and *Scirpus*. Several collections of sclerotia of this species, including both European and American specimens, have been examined. The sclerotia were, as a rule, more slender than those of the *Carex* form. They were mostly about 1 mm. in diameter and did not exceed 1.5 mm. whereas the sclerotia on *Carex* were up to 3 mm. in diameter. It is questionable, however, whether any taxonomic significance could be attached to this difference.

It has not been possible to examine the perithecia of *C. nigricans*. No account of the perithecial stage is known to the writer apart from the original description and figures of Tulasne (1853). Seaver (1910) stated that the perithecia had not been observed in North America, and Petch (1938) had no record of them for Great Britain. Tulasne did not give measurements of the asci and spores. He distinguished the species chiefly on the basis of the color, "Je la désignerai par le nom de *Claviceps nigricans*, à cause de la couleur très sombre, d'un violet presque noir, qui affecte toutes ses parties, mêmes dès ses premiers commencements."

It is impossible to reconcile the colors observed in the perithecial stromata of this species with this statement of Tulasne, and it is, therefore, concluded that this species is ˙distinct from *C. nigricans*.

The colors of the *Carex* ergot are similar to those of *Claviceps purpurea* as described by Whetzel and Reddick (1911). Two specimens with good perithecial material of *C. purpurea* have been examined, Rehm Ascom. *1380*, and a Danish specimen from O. Rostrup in the Mycological Herbarium of the Division of Botany and Plant Pathology, Department of Agriculture, Ottawa. Both of these were collected on *Glyceria fluitans* (L.) R. Br. They were very similar morphologically to the *Carex*-inhabiting species and no clearly marked differences could be found.

It would seem noteworthy, however, that in the examination of a large number of collections of sclerotia of *C. purpurea* from various hosts, no evidence of larval infestation could be found, whereas it has been very difficult to find sclerotia of the *Carex*
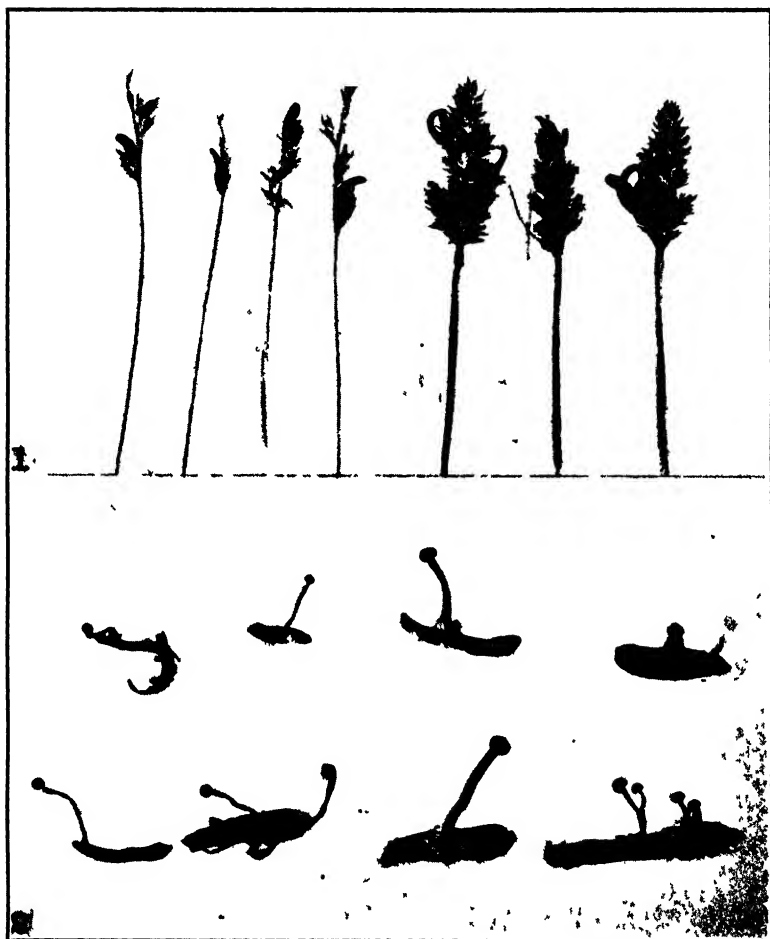
FIG. 1, sclerotia of *Claviceps Grohii* on two species of *Carex*, × 1;
2, perithecial stromata of *C. Grohii*, × 2.

species free from larvae.[3] This would indicate a very distinct physiological difference. Furthermore *C. purpurea* has never been shown to infect hosts other than Gramineae and it would seem to be an unjustifiable assumption to extend its host range to the Cyperaceae unsupported by cultural evidence. In addition a certain amount of specialization within the host genus *Carex* is indicated by the fact that all of the species reported below

[3] Evidence of larval infestation was observed in some collections of sclerotia of *C. nigricans*.

as hosts fall within the groups having more than one flower spike and plano-convex rather than triangular achenes.

It has, therefore, been decided to describe the *Carex* ergot as a new species and to name it in honor of Mr. Herbert Groh who first recorded its occurrence and thirty years later provided the material from which the perithecial stage was obtained.

Claviceps Grohii sp. nov.

Sclerotiis semicylindricis, curvulis vel fere rectis, 5–15 mm. longis, 1–3 mm. diam., atro-violaceis; stipitibus flexuosis, glabris, 4–15 mm. longis, 0.2–0.5 mm. diam., atro-violaceis vel atro-brunneis; capitulis subglobosis, carnosis, "buff-pink" vel "orange vinaceous" (R), ab ostiolis prominulis obscurioribus punc-tulatis; peritheciis immersis, ovoideis, 150–300 × 100–150 μ; ascis cylindraceis, flexuosis, apice rotundatis, basi attenuatis, octosporis, (100)–125–160–(175) × 5–6 μ; ascosporis hyalinis, filiformibus, continuis, (75)–90–125 × 1.0–1.5 μ.

Hab. in ovariis *Caricis* spp.

Sclerotia semicylindric, usually more or less flattened on one side, curved or nearly straight, 5–15 mm. in length, 1–3 mm. in diameter, blackish violet, close to "dark heliotrope slate" to "dull purplish black," "pinkish buff" to "pale pinkish buff" within; perithecial stromata one to several from a sclerotium, stalks 4–15 mm. in height, 0.2–0.5 mm. in diameter, blackish violet to blackish brown, glabrous except for a tuft of pale violet mycelium at the base, compressed and twisted when dry, the heads more or less globose, 0.8–2.0 mm. in diameter, fleshy, "buff-pink" to "orange vinaceous," rough-punctate with the darker orange perithecial ostioles; perithecia immersed, ovoid, 150–300 × 100–150 μ; asci cylindric, flexuous, rounded above, narrowed below, eight spored, (100)–125–160–(175) × 5–6 μ; ascospores hyaline, filiform, continuous, (75)–90–125 × 1.0–1.5 μ.

Host: in the ovaries of *Carex* spp., *C. angustior* Mack., *C. brunnescens* Poir., *C. muricata* L. (?), *C. scirpoides* Schkuhr., *C. stellulata* Good.; (fide Lepage) *C. stipata* Muhl., *C. tribuloides* Wahl.

Specimens Examined: Mycological Herbarium of the Division of Botany and Plant Pathology, Department of Agriculture, Ottawa. *12072*, Type. On *Carex stellulata* Good., Milner, B. C., Coll. H. Groh, July, 1939, Perithecia produced Jan. 1940.

Sclerotia only—*2389, 2744*, Rimouski, Que.; *4313*, Beauce Co., Que.; *4319*, Ste. Anne de la Pocatiere, Que.; *5673*, Beauceville, Que.; *5927*, Anticosti Island; *12073*, Aldergrove, B. C.

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LITERATURE CITED

Bonns, Walter W. A preliminary study of *Claviceps purpurea* in culture. Am. Jour. Bot. **9**: 339–353. 1922.

Brefeld, O. Untersuchungen aus dem Gesammtgebiete der Mykologie. Bd. **X**. Münster. 1891.

Griffiths, David. Concerning some West American fungi. Bull. Torrey Club **29**: 290–301. 1902.

Groh, H. A new host for *Claviceps*. Mycologia **3**: 37–38. 1911.

Lepage, Abbé Ernest. L'Ergot du *Carex* et son parasite *Acylomus ergoti*. Le Naturaliste Canadien **65**: 75–77. 1938.

Petch, T. British Hypocreales. Trans. Brit. Myc. Soc. **21**: 243–305. 1938.

Seaver, F. J. Hypocreales. N. Am. Flora **3**: 1–56. 1910.

Tulasne, L. R. Memoire sur l'Ergot des Glumacees. Ann. Sci. Nat. III. **20**: 5–56. 1853.

Whetzel, H. H. North American species of *Sclerotinia* II.—Two species on *Carex, S. Duriaeana* (Tul.) Rehm, and *S. longisclerotialis* n. sp. Mycologia **21**: 5–32. 1929.

Whetzel, H. H. & Reddick, Donald. A method of developing *Claviceps*. Phytopath. **1**: 50–52. 1911.

SOME EVIDENT SYNONYMOUS RELATION-
SHIPS IN CERTAIN GRAMINICOLOUS
SMUT FUNGI [1, 2]

GEORGE W. FISCHER [3]

(WITH 4 FIGURES)

INTRODUCTION

In the various taxonomic treatments of the smut fungi many flagrant cases still exist where synonymous relationships have gone unrecognized or unheeded. There is still a strong tendency in studies of the smut fungi to place too much emphasis on the host plant in the delimitation of species, and to give too little recognition to the possibility of the existence of physiologic and slight morphologic variants within species. In the one case species are sometimes separated solely on supposed specialization to a single genus of plants, and in the other, species are separated by a demonstration of insignificant biometric differences. Both of these methods have contributed to the recognition of many species that are not valid on purely morphologic grounds. Some species defy determination if the host plant is not known to genus and sometimes even to species. Or one would be obliged to measure at least 200 spores in order to arrive at a species determination. Such a condition does not exist in many other well recognized and thoroughly studied plant pathogens. For example any of the common cereal rust species (*Puccinia graminis* Pers., *P. rubigovera* (DC.) Wint., *P. glumarum* (Schm.) Erikss. & P. Henn., and *P. coronata* Corda.) are readily identified without any reference

to host plants and these are numerous for each species. Powdery mildew (*Erysiphe graminis* DC.) of cereals and grasses is readily recognized and identified without reference to host plant, as are also other powdery mildews and downy mildews which have numerous host species.

It is the purpose of this paper to call attention to some of the instances of unrecognized or unheeded synonymy in the grass and cereal smuts and to recommend desirable consolidations.

USTILAGO AVENAE, U. PERENNANS, AND U. NIGRA

Fischer and Holton (5) recently recommended the uniting o *Ustilago Avenae* (Pers.) Jens. (loose smut of oats) and *U. peren nans* Rostr. (smut of *Arrhenatherum elatius* (L.) Mert and Koch)
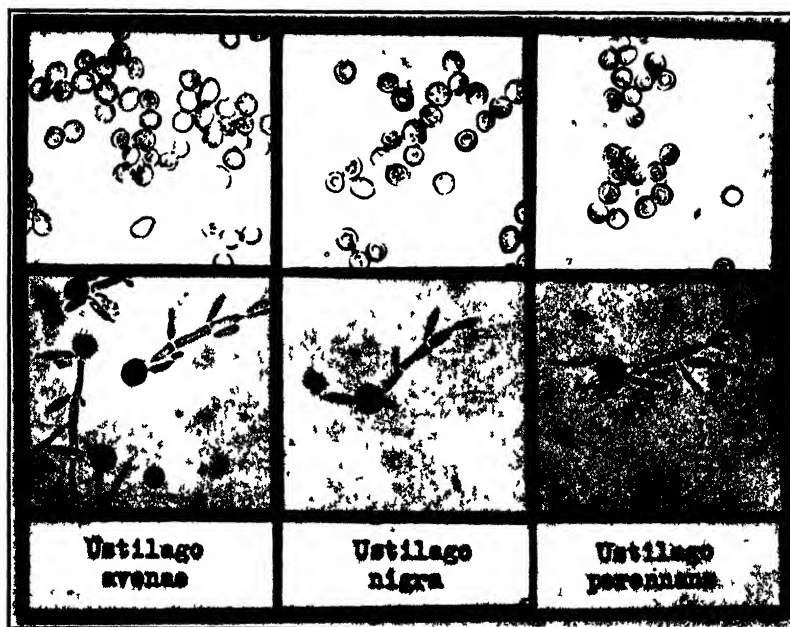
FIG. 1. Spores and germinating spores of *Ustilago Avenae*, *U nigra*, and *U. perennans* showing comparative morphology. Each species photographed under same conditions of equipment, lighting, and magnification. × about 400.

because of demonstrated genetic relationship and morphological identity. Further study has now indicated that *U. nigra* Tapke (7, 8) should be included in the consolidated species. This latter

form causes a black loose smut which, in our present state of knowledge, is confined to barley (*Hordeum vulgare* L.) and certain grasses also of the tribe Hordeae (**3, 8**). The symptoms are the same, the fungus causing a typical dark-brown to black loose smut on the several hosts involved and the life history of the organism is essentially the same in all. As seen in figure 1, *U. perennans*, *Avenae*, and *U. nigra* are indistinguishable morphologically and for this as well as for the reasons previously mentioned, it is proposed that the three be considered merely as specialized varieties of one morphological species.

The legitimate binary name under the provisions of the International Rules of Botanical Nomenclature would appear to be *Ustilago Avenae* (Pers.) Rostr., with pertinent synonomy as indicated hereafter. It is regretted that priority will not permit the use of Tapke's specific epithet *nigra*, since it is descriptive of the dark brown to black sori of this species; while on the other hand *Avenae* implies specialization to the genus *Avena*.

Ustilago Avenae Jens. as listed in Jensen's paper Le Charbon des Cereales, p. 4, 1889 is the binomial cited for this smut but since Jensen does not indicate whether he is basing his name on Persoon's subspecies or is naming it "de nova," the Rostrop combination is to be preferred. Biedenkopf's *U. medians* is based on a mixture of barley smuts (**8**) and the name is rejected as a *nomen ambiguum*. Other names applied to the form on *Arrhenatherum* including *Ustilago decipiens* (Wallr.) Liro and *U. Holci-avenacei* (Wallr.) Cif. are likewise not available on the basis of priority.

Zundel (9) reduces *U. nigra* Tapke to synonymy under *U. nuda* Rostr., which also causes a loose smut of barley, but whose characteristics of spore germination, life history and control mark it as entirely distinct. Its relationships are discussed later on in this paper.

USTILAGO AVENAE (Pers.) Rostr. Overs. K. Danske Vid. Selsk. Forh. **1890**: 13. Mar. 1890.

    Uredo segetum subsp. *Avenae* Pers. Syn. Fung. p. 224. 1801.
    Uredo segetum forma *decipiens* Wallr. Ann. Bot. p. 139. 1815.
    Erysibe vera var. *Holci-avenacei* Wallr. Fl. Crypt. Germ. **2**: 217. 1833.

Ustilago Avenae Jens. Le Charbon des Cereales, p. 4.   1889.

Ustilago perennans Rostr. Overs. K. Danske Vid. Selsk. Forh.
1890: 15.   March 1890.

Ustilago Avenae Jens. ex Kellerm. & Swing. Ann. Rept. Kans.
Agric. Expt. Sta. **2**: 215.   June, 1890.

Ustilago medians Biedenk. Zeits. Pflanzenkr. **4**: 321.   1894.

Ustilago decipiens Liro, Ann. Acad. Sci. Fenn. A. **17**: 95.   1924.

Ustilago nigra Tapke, Phytopath. **22**: 869.   1932.

Ustilago Holci-avenacei Cif. Fl. Ital. Crypt. 1 (17): 293.   1938.

USTILAGO HORDEI AND U. KOLLERI (U. LEVIS)

Ustilago Hordei (Pers.) Lagh. and *U. Kolleri* Wille, the latter
commonly referred to by American workers as *U. levis* (Kellerm.
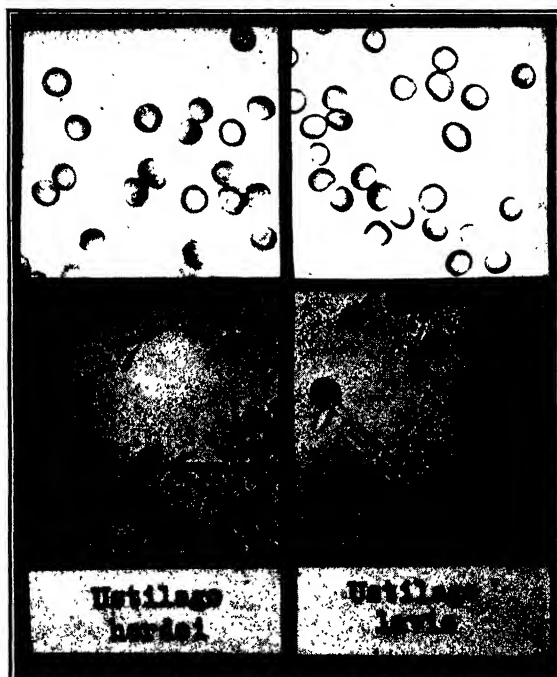
FIG. 2.   Spores and germinating spores of *Ustilago Hordei* and *U. levis*
showing comparative morphology.   Both species photographed under same
conditions of equipment, lighting, and magnification.   × about 400.

& Swing.) Magn., are two morphologically identical forms causing
"covered" smuts of barley and oats respectively.   Both forms

have small spores (5–8 μ in diameter) which are smooth and generally lighter colored on one side (FIG. 2).   These two forms, therefore, are separable entirely on a host specialization basis, the one occurring on cultivated barley (*Hordeum* spp.) and certain other grasses of the tribe Hordeae (**2, 3**); the other on *Avena* spp. Since these two forms are not distinct morphologically it is recommended that they be considered specialized varieties of a morphological species which by priority should be designated as *U. Hordei* (Pers.) Lagh.   It is unfortunate that circumstances do not permit the use of the descriptive epithet *levis* as *U. levis*, since it refers to the smooth nature of the epispore, the one morphological character which distinguishes *U. Hordei* from *U. Avenae*, with its echinulate spores.

USTILAGO HORDEI (Pers.) Lagerh. Mitt. Badeschen Bot. Ver. p. 70   1889.

> *Uredo segetum* subsp. *Hordei* Pers. Syn. Fung. p. 224.   1801.
>
> *Ustilago Avenae* var. *levis* Kellerm. & Swing. Ann. Rept. Kans. Agric. Exp. Sta. **2**: 259.   1890.
>
> *Ustilago levis* Mag. Ber. Natur-Wiss.-Mediz. Ver. Innsbruck **21**: 22.   1894.
>
> *Ustilago Kolleri* Wille, Bot. Notiser **1893**: 10.   1893.

USTILAGO TRITICI AND U. NUDA

Cultivated wheat (*Triticum* spp.) and cultivated barley (*Hordeum* spp.) are commonly and often seriously affected with loose smuts, of which the causal organisms have been known as *Ustilago Tritici* (Pers.) Rostr. and *U. nuda* (Jens.) Kellerm. & Swing., respectively.   Both Cunningham (**1**) and Rodenhiser (**6**) have earlier proposed the consolidation of these two species.   These "species" are identical in every way except pathogenicity.   Both have small, spherical to subspherical spores (5–8 μ), which are minutely echinulate, and lighter colored on one side (FIG. 3).   Both are characterized by "blossom infection" of the host plants, and the germination of the spores (on nutrient media or otherwise) to form a mycelium directly, without producing promycelia and sporidia. Such being the case, the loose smuts of wheat and barley, hitherto known as *U. Tritici* and *U. nuda*, respectively, should be regarded as specialized varieties of the same morphologic species, which by priority should bear the name *Ustilago Tritici* (Pers.) Rostr.
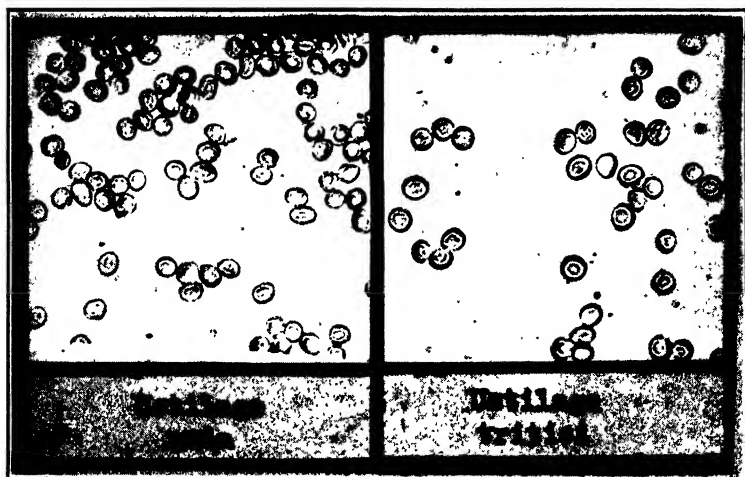
FIG. 3.   Spores of *Ustilago nuda* and *U. Tritici* showing comparative morphology.   Both photographed under same conditions of equipment, lighting, and magnification.   ✕ about 400.

USTILAGO TRITICI (Pers.) Rostr. Overs. K. Danske Vidensk. Selsk. Forh. **1890**: 15.   March 1890.

> *Uredo segetum* subsp. *Tritici* Pers. Syn. Fung. p. 224.   1801.

> *Ustilago segetum* var. *nuda* Jens. Jour. Roy. Agric. Soc. England 24 (Ser. 2): 406.   1888.

> *Ustilago Tritici* Jens. in Kellerm. & Swing. Ann. Rept. Kans. Agric. Expt. Sta. **2**: 262.   June 1890.

> *Ustilago nuda* Kellerm. & Swing. Ann. Rept. Kans. Agric. Expt. Sta. **2**: 277.   June 1890.

UROCYSTIS AGROPYRI, U. TRITICI, AND U. OCCULTA

Numerous grasses, cultivated wheat, and cultivated rye have long been subject to attack by a stripe smut (known popularly as flag smut) in North America, Europe, Asia, and Australia, the causal organisms of which have been known as *Urocystis Agropyri* (Preuss) Schroet., *U. Tritici* Koern., and *U. occulta* (Wallr.) Rab., respectively.   The general symptoms of flag smut on the three groups of hosts are the same, and the three smut species themselves are morphologically indistinguishable except for a tendency of the spores of *U. occulta* to be incompletely invested by the

sterile cells   This morphological similarity of the three flag smut species has long been recognized, and they have been separated almost entirely on a host specialization basis   Recently, even this basis of separation has been partially broken down (4) when
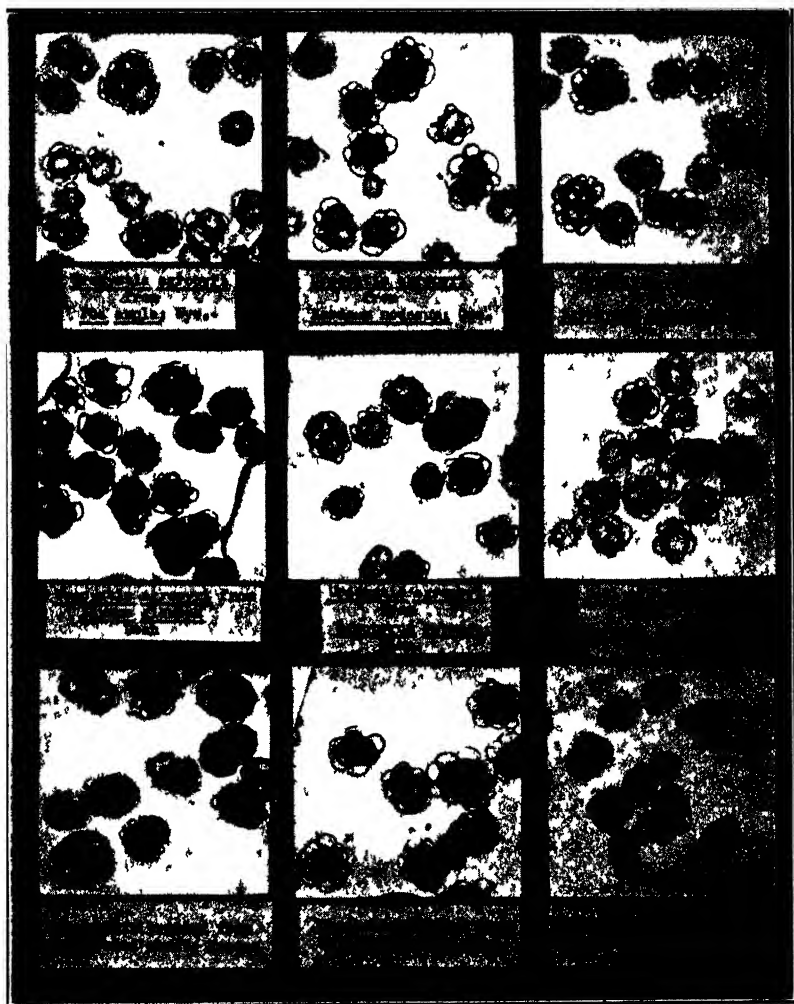
FIG 4   Spore balls of *Urocystis Agropyri* (from various hosts and localities), *U Tritici*, and *U occulta*, showing comparative morphology   All photographed under same conditions of equipment, lighting, and magnification   × about 250   Retouched, that is, the faint outlines of some of the sterile cells were traced over with diluted India ink.

it was known that *U. Tritici* and *U. occulta* both will infect certain grasses.

A recent study, by the author, of dozens of specimens of the three flag smut species indicates that *Urocystis Agropyri* and *U. Tritici* are not morphologically separable, while *U. occulta* is fairly distinct because of the incomplete investment of the spore balls. Otherwise the three "species" are inseparable on the basis of size and shape of spore balls, number of spores therein contained, and in the size and shape of the spores themselves. Some idea of the comparative morphology of *U. Agropyri*, *U. Tritici*, and *U. occulta* may be seen in figure 4.

Urocystis Agropyri has been known to occur in the United States for several decades and over 30 species in 10 genera of grasses are known to be hosts. Herbarium specimens of flag smut under the name *U. Agropyri* from all of the 10 genera of grass hosts have recently been examined with the result that more variation was noted among the numerous collections of *U. Agropyri* than between this species as a whole and *U. Tritici*. Only a few of the specimens showed any tendency toward incomplete investment of the spore balls with sterile cells, as distinguishes *U. occulta*.

Since *Urocystis Agropyri* and *U. Tritici* are morphologically identical, it seems logical to consider them as one species. If the flag smut of wheat were to continue to be considered as a separate species then the smut on each of the ten other genera of grasses equally merits specific distinction. Thus there would result almost a dozen "species" causing flag smut, and probably none of them separable morphologically. Therefore, in view of this, and considering the demonstration (4) of the susceptibility of several species of grasses to *U. Tritici* it is recommended that this species and *U. Agropyri* be combined under the latter name which has priority. It might even be desirable to include *U. occulta* in the composite species, but at the present it seems preferable to keep it separate because of the incomplete investment of the spore balls by the sterile cells (FIG. 4).

UROCYSTIS AGROPYRI (Preuss) Schroet. Abh. Schles. Ges. Abth. Not. Med. **1869–72**: 7. 1870.

  Uredo Agropyri Preuss in Sturm, Deutsch. Fl. III. **25**: 1. 1848.
  Urocystis Tritici Koern. Hedwigia **16**: 33. 1877.

SUMMARY

Some evident cases of synonomy in certain graminicolous smut fungi are presented and desirable consolidations are recommended.

Ustilago nigra, U. Avenae, and U. perennans, causing dark brown to black loose smuts of barley, oats, and tall oatgrass, respectively, are considered as specialized varieties of a single morphologic species, which, according to International Rules of Botanical Nomenclature would bear the name U. Avenae although U. nigra would be more descriptive.

It is recommended that the covered smuts of barley and of oats, Ustilago Hordei and U. Kolleri, respectively, be considered as specialized varieties of a single morphologic species, which by priority would be called U. Hordei.

Emphasis is given to earlier proposals that Ustilago Tritici and U. nuda, causing loose smuts of wheat and of barley, respectively, be considered as specialized varieties of the same morphologic species, which by priority would bear the name U. Tritici.

Urocystis Agropyri, U. Tritici, and U. occulta, causing flag smuts of grasses, wheat, and rye, respectively, are shown to be very similar in morphology and in the effect on the host plants. In fact, the first two are considered identical, and it is recommended that they be consolidated under one name, which by priority would be U. Agropyri. Urocystis occulta seems to have one fairly constant distinguishing morphologic character in that the spore balls are more or less incompletely invested by the sterile cells, and at present it seems preferable to retain it as a separate species.

.LITERATURE CITED

1. **Cunningham, G. H.** The Ustilagineae, or 'smuts' of New Zealand. Trans. New Zealand Inst. **55**: 397–433. 1924.

2. **Fischer, George W.** Some new grass smut records from the Pacific Northwest. Mycologia **30**: 385–395. 1938.

3. ———. Studies of the susceptibility of forage grasses to cereal smut fungi. II. A preliminary report on *Ustilago hordei* and *U. nigra*. Phytopath. **29**: 490–494. 1939.

4. ———. Infection of forage grasses with flag smuts of wheat, rye, and grasses (*Urocystis tritici*, *U. occulta*, and *U. agropyri*, respectively). Abstract, Phytopath. **32**: 4–5. 1942.

5. ——— **& Holton, C. S.** Inheritance of sorus characters in hybrids between *Ustilago Avenae* and *U. perennans*. Mycologia **33**: 555–567. 1941.

6. **Rodenhiser, H. A.** Physiologic specialization of *Ustilago nuda* and *Ustilago Tritici*. Phytopath. **16**: 1001–1007. 1926.

7. **Tapke, V. F.** An undescribed loose smut of barley. Phytopath. **22**: 869. 1932.

8. ——. Occurrence, identification, and species validity of the barley loose smuts, *Ustilago nuda*, *U. nigra* and *U. medians*. Phytopath. **33**: 194–209. 1943.

9. **Zundel, G. L.** Additions and corrections to *Ustilaginales*. North American Flora **7** (14): 971–1045. 1939.

STUDIES IN THE GASTEROMYCETES—IX.
THE GENUS, ITAJAHYA IN
NORTH AMERICA

W. H. LONG AND DAVID J. STOUFFER

(WITH 10 FIGURES)

This paper reports the discovery of the genus, *Itajahya*, in North America, discusses the genus, gives a description of the North American plants and records data on their distribution.

While on a collecting trip during September, 1941, through the arid regions of Arizona and New Mexico, we found a phalloid which at a casual glance seemed to be a white form of *Phallus impudicus;* hence no special effort was made to collect many specimens. Later a closer study of the plant showed that it was not *P. impudicus*, but a form unknown to either of us. A special search was then made for as many specimens as we could find. We decided that it might be an *Itajahya*, but it seemed improbable that a tropical, wet climate plant could grow under such arid conditions.

On returning home a careful study of our phalloid proved conclusively that it did belong to the genus, *Itajahya*, in spite of its desert habitat. This is the first time this genus has been reported from North America.

Itajahya was first reported and described from Brazil by Alfred Moller (**1895**), found by him near Blumenau. Later the plant was recorded by Lloyd (**1907**) from Pelotas, another locality in Brazil, and finally Robert E. Fries (**1909**) reported the phalloid from Bolivia and Spegazzini (**1899**) listed a plant from Argentina under the genus name *Alboffiella* which Fries and others have decided is synonymous with *Itajahya*. Fries states that *Itajahya galericulata* is probably distributed over the greater part of the warmer regions of South America where conditions are favorable.

THE ARIZONA AND NEW MEXICO SPECIMENS

These plants have all the general characters of the genus, *Itajahya*, the white calyptra, lamellate plates, covered by the gleba

and permeating the inner structure of the pileus (FIG. 4), the white mottled surface of the gleba (FIG. 1, 3), the wig-like surface of the pileus when denuded of its gleba (FIG. 6) and the thick, stout stem with its many chambered walls (FIG. 8). They differ in usually having a well defined, membranous veil (FIG. 9), in a circumscissile volva (FIG. 2, 3, 7, 10) with the upper portion remaining as a cap over the pileus (FIG. 1, 2, 10), with pileus flattened on top (FIG. 2, 10) from the pressure of the volva when the plants elongate, and especially in having an entirely different habitat, since they grow in arid regions while the usual habitat in Brazil is a wet, humid region.

The presence or absence of a membranous veil is not of specific value since such well known phalloids as *Phallus impudicus, P. rubicundus* and others may or may not have this membranous veil, and even some of our *Itajahya* plants do not have it. The circumscissile volva and the flat top of the pileus are due to local conditions when the plants grow in arid regions as explained by Long in his Phalloideae of Texas (**1907** p. 113). The dry habitat was very unexpected, although Fries (l.c.) found these plants in Bolivia in abundance in dry, sandy locations where vegetation was very sparse, as well as in shady areas under thick shrubbery in rich humus. Such conditions approach those in which our plants were collected. Möller mentions plants with volva adhering to top of pileus. Lloyd (**1907**) describes and figures a plant with a volva cap on pileus, while Fries mentions and figures plants with the volva adhering to the top of the pileus. These various plants seem intermediate as to volva cap, between the usual naked pileus of Brazilian and the adnate volva cap of our North American plants. In view of the above data we have decided that our plants do not warrant the erection of a new species, but belong under *Itajahya galericulata* since all the differences found are minor and mainly due to the climatic conditions under which the plants grew.

ITAJAHYA GALERICULATA IN NORTH AMERICA

Sporophore when young (egg stage) ovate to subglobose, 2–3 cm. across by 3–5 cm. tall with a radicating base, originating 5–8 cm. below the surface of the soil, when mature and elongated consisting of a volva, stipe and pileus. *Volva* circumscissile (FIG.

2, 3, 7), upper portion borne as a cap on top of the pileus when the plant elongates, often covering the entire gleba (FIG. 10), white with slight pink tinge when fresh becoming tilleul brown in age.

FIGS 1–6.   *Itajahya galericulata*

Stipe cylindrical to somewhat fusiform, tapering rapidly to a point inside of volva cup, white when fresh changing to cartridge buff on drying, 4–15 cm. tall (many only 4–6 cm. tall) by 1½–2 cm. in

diameter in thickest portion (middle), stem cavity 7–15 mm. in diameter, expanding into a funnel inside pileus, 1–2 cm. wide at top, covered by the calyptra (FIG. 2), margin of funnel spreading

FIGS. 7–10.   *Itajahya galericulata.*

over top of gleba as a crenulate white collar or border; *calyptra* white with dentate edges, covering entire top of pileus, 1–2½ cm. in diameter by 1–1½ mm. thick, tough, becoming free from the

collar but held in place by the volva cap; *walls* of stipe thick, tough, composed of isodiametric chambers which open outwardly as small pores while a few may open inwardly, 2–3 chambers thick at base of stem, 4–5 in middle of stem and 3–4 chambers thick at top. *Pileus* cylindrical-campanulate, 1–2½ cm. across by 1–2 cm. tall, flattened on top by the adhering volva cap (FIG. 10), often unsymmetrical, one half being larger than the other, undersurface white and free from the stem but often clasping the stem tightly. *Veil* thin, membranous, non-perforate, appearing as white bands of tissue on stem (FIG. 9) and as a white cup enclosing the base of the stem inside the volva cup (FIG. 5). *Gleba* when fresh olive gray to mouse gray turning black on deliquescing, moderately foetid, attached to underside of border and to the inside wall of pileus, formed of lamellate, overlapping trama plates which traverse the entire pileus and divide repeatedly (FIG. 4), terminating on the outer surface of the gleba as white, irregular spots giving the surface a mottled appearance (FIG. 1, 3); when the gleba is carefully washed off, the surface of the pileus takes on a wig-like appearance as shown in figure 6.[1] *Spores* 1.5–2 μ by 3–3.5 μ, hyaline, smooth.

Habitat: Solitary or in groups of 2–4 individuals, in sandy-clay soil on top of mesquite (*Prosopis juliflora*) sandhill dunes, under the trees and immediately adjacent to the tree trunks (in New Mexico); in mesquite-catclaw flats (*Prosopis-Acacia*) (in Arizona), and in mesquite-cactus (*Opuntia*) areas (in Texas); in arid or semi-arid regions.

DISTRIBUTION IN NORTH AMERICA

Arizona. Santa Cruz County, 7 miles north of Nogales on Nogales-Tucson Highway 89, elevation 3857 feet, *W. H. Long and Victor O. Sandberg*, November 11, 1933—*1 plant 7849.* Pima County, 8 miles from Tucson on road to Sabino Canyon, elevation 2400 feet, *W. H. Long and Victor O. Sandberg*, September 22, 1934 —*4 plants 8016: W. H. Long*, September 29, 1934—*1 plant 8382.*

New Mexico. Dona Ana County, Jornado Experimental Range, elevation 4150 feet, *W. H. Long and David J. Stouffer*, September 8, 1941—*2 plants 9602.* Luna County, 10 miles west of Deming on Highway 70, elevation 4300 feet, *W. H. Long and*

[1] Figures 4 and 6 were copied from plate 8 of Alfred Möller's Brasilischen Pilzblumen and show the plants twice their natural size, all other figures show the plants natural size; figures 7, 8, and 10 are made from photographs of the Texas material, while the remaining figures are from New Mexico specimens.

David J. Stouffer, September 12, 1941—*7 plants 9641;* September 13, 1941—*21 plants 9656.*

Texas. Starr County, Falfurrias, elevation 300 feet, *Dr. O. F. Cook.* September 1909—*several plants.*

The above descriptions and data were made from the Arizona-New Mexico-Texas plants. The field notes and 6 different sets of photographic prints are in the files of the senior author, while negatives of these prints are filed with the Mycological Collections of the Bureau of Plant Industry at Beltsville, Maryland. All of the specimens listed in this paper are deposited in the Long Herbarium at Albuquerque, New Mexico.

ILLUSTRATIONS: Schimp. Bot. Mett. aus den Tropen 7: Brazilischen Pilzblumen, *pl. 5, f. 1–4; pl. 8, f. 27–34;* Ark. Bot. **8**: no. 11, *tab. 1, f. 1–2, tab. 2, f. 1–5;* An. Mus. Nac. Buenos Aires **6**: *tab. 4, f. 1 (a, a, o,), tab. 6, f. 1;* Myc. Writ. **2**: *pl. 121, f. 1–3;* Phal. *f. 21, 22;* E. & P. Nat. Pfl. **1**: 1**, *f. 143 A–C;* E. & P. Nat. Pfl. **A**: *f. 77 A, B, C.*

THE ARIZONA-NEW MEXICO AREAS

The mesquite-sandhill dunes near Deming, New Mexico, consist of mounds of varying areas with heights ranging from 3 to 5 feet. These dunes are wind made and are composed of a sand-clay soil. They are covered with scrubby mesquite brush, of which only a few trees reach a height of 15 feet. The region is arid and crops grown there require irrigation; however none of the irrigation water ever gets over the dunes.

The *Itajahya* plants grow on top of the dunes in the midst of the mesquite brush and are located at the base of the larger trees where they are protected from the sun and strong winds and can utilize the water that runs down the tree trunks during rains; even a small shower will furnish some water to the plants.

The mesquite-sandhill dunes on the Jornado are usually taller and are composed of deep sand with larger mesquite trees than the Deming dunes. The *Itajahya* plants also grow on top of these dunes at the base of the trees.

The mesquite-catclaw flats where the *Itajahya* grows in Arizona have scattered trees of *Prosopis juliflora* and *Acacia Greggii.* The soil is a heavy clay-sand with a limestone subsoil. Here again our plants are found at the base of the trees next to the trunks.

THE TEXAS MATERIAL

The Texas plants were collected by Dr. O. F. Cook near Falfurrias in September 1909 and were sent to the Mycological Collections of the Bureau of Plant Industry at Washington, D. C., but this material can not now be located.   However Dr. Cook made a number of very fine photographs and field notes at the time the plants were collected.   These have given us an excellent idea of the characters of this phalloid.   The plants have the white calyptra (FIG. 10), the lamellate, overlapping trama plates bearing the gleba throughout the body of the pileus, and the stout, thick stems with its many chambered walls (FIG. 8).

They differ from the Arizona-New Mexico material in having a cylindrical pileus completely covered with the volva caps (FIG. 7, 10), the absence of any veil, pileii with flattened tops (FIG. 7, 10) and circumscissile volvas (FIG. 7, 10) which remain on the pileii after elongation and in having the pores of the stems open both outwardly and some inwardly; these constitute the main differences between the Texas material and our Arizona-New Mexico plants.   We are convinced that the Texas phalloid is the same species as ours, somewhat modified by environment but the differences not sufficient to warrant the erection of a new species.

The Texas area where these plants were found is an arid region but with rich black soil, originally covered with open stands of mesquite and cactus.   Much of this native vegetation had been cleared away and the land put in cultivation under irrigation shortly before the phalloid was found.   The *Itajahya* plants were growing in an old cotton field where they had to push through 2–3 inches of very hard, sunbaked soil when they elongated.   This explains their flattened tops, cylindrical pileii and circumscissile volvas.

India.   Ahmad (1940) in his paper on the Higher Fungi of the Punjab Plains figures and describes a phalloid which he identified as *Itajahya galericulata*.   In a later publication (1941), however, he states that this identification was incorrect and that his plant was *Dictyophora irpicina* (*Clautriavia merulina* (Berk.) Lloyd). We have been fortunate to obtain a specimen of this plant and agree with Ahmad that it is not *Itajahya galericulata* but is some species of *Clautriavia.*

Itajahya in South America is a very variable plant according to Möller and Fries. The variations are mainly in the size and development of the border of the funnel of the receptaculum and in the size and character of the calyptra. The extremes are often so great that one could call them two different species if seen alone without connecting forms. Möller (l.c.) aptly states this characteristic in the following language, "In every part of the sporophore, as well as in the thickness of the stem, an unusual instability of form prevails in this fungus. For this reason it is particularly necessary to observe and compare as great a number of individuals as possible, if one is not to fall into the temptation of establishing a special species for each one." Fries also states that "the different aspects presented by this fungus due to differences in extent of development of the receptaculum, the presence or absence of the calyptra show that they can be considered in systematic work only when a wide range of material is observed." This instability of form is not very pronounced in our North American plants, consisting mainly in the varying sizes of the individuals and the shape of the pileus. The funnel of the receptaculum and the calyptra are fairly constant.

The Brazilian plants grow under very different conditions from our North American plants. Möller reports his first specimen as growing on a rather steep clay bank of a forest brook, near Blumenau in the Province of Santa Catherina in Southern Brazil. Other individuals were obtained at intervals in the same place for $2\frac{1}{2}$ years, all from a spot scarcely one square kilometer in extent, among the roots of a dead fig tree where the soil was rich in decaying leaves. Later Möller also found the plant in other localities near Blumenau, one place had an elevation of 1312 feet above sea level. The phalloid was also found in Rio de Janeiro by Glaziou among dead bamboo roots.

John N. Couch and Mrs. Alma H. Beers of the University of North Carolina for loan of material.

ALBUQUERQUE, NEW MEXICO
AND
CORONA, NEW MEXICO

BIBLIOGRAPHY

Ahmad, Sultan.   1940.   The higher fungi of the Panjab Plains II, The Gastero-mycetes.   Jour. Ind. Bot. Soc. **18**: 174.

——.   1941.   The higher fungi of the Panjab Plains III, The Gasteromycetes.   Jour. Ind. Bot. Soc. **20**: 141.

Fischer, Ed.   1900.   The Phallineae.   E. & P. Nat. Pfl. **1**: 1**, 291–292.

——.   1933.   The Phallineae.   E. & P. Nat. Pfl. **7A**: 101–102.

Fries, Robert E.   1909.   Über einige Gasteromyceten aus Bolivia und Argentinien.   Ark. Bot. **8**: no. 11, 3–7.

Long, William H.   1907.   The Phalloideae of Texas.   Jour. Myc. **13**: 113.

Möller, Alfred.   1895.   Brazilischen Pilzblumen, 79–100 et 148, in Schimp. Bot. Mitt. aus den Tropen **7**: 79, *pl. 5*.

Saccardo, P. A.   1895.   Syll. Fung. **11**: 153–154.

——.   1902.   Syll. Fung. **16**: 227–228.

Spegazzini, Carlos.   1899.   Fungi. Argent. novi vel criti.   An. Mus. Nac. Buenos Aires **6**: 183.

FUNGI NOVI DENOMINATI—I.

John A. Stevenson

The following fungi received from sources as indicated appear to be heretofore undescribed, but worthy of a name.   Type specimens are deposited in the Mycological Collections of the Bureau of Plant Industry, Plant Industry Station, Beltsville, Maryland. Portions of the type collections of the Muller species from Brazil are also deposited in the herbarium of the Department of Plant Pathology, Cornell University and in the private herbarium of A. S. Muller.   Where the material was adequate portions of the type collection of other species here named have been deposited in other mycological herbaria as indicated.

Meliola (Irenina) Buettneriae sp. nov.

Colonies 2–3 mm. diameter, compact, circular, scattered, not coalescing, amphigenous, but for the most part epiphyllous, and at times caulicolous, producing definite brown spots on host tissue; *hyphae* compact, branching commonly opposite, and at acute angles, 8–9 μ diameter; *capitate hyphopodia* alternate or unilateral, numerous, often touching, sessile or short-stalked, 15–30 μ long, 12–15 μ diameter; *stalk cell* cylindrical 3–6 μ long, 6 μ diameter; *head cell* broadly ovate to somewhat lobed or irregular, 12–15 μ diameter; *mucronate hyphopodia* few, opposite, or unilateral, 8–9 μ diameter at base, tip long cylindrical, 3 μ diameter; *mycelial* and *perithecial setae* none; *perithecia* few at center of colonies, rough, globose, 150–200 μ diameter; *asci* 2-spored, evanescent; *spores* 4-septate, deep brown, smooth, constricted at septae, 42–45 × 14–15 μ.

Formula under the Beeli system, 3103. 4220.

On living leaves and twigs of *Buettneria ramosissima* Pohl. (Sterculiaceae), Uberlandia, Minas Gerais, Brazil, A. S. Muller, *1058* (Type), May 16, 1936.

Coloniis amphigenis, plerumque epiphyllis et caulicolis, circularibus; *hyphis* 8–9 μ crassis, ramis plerumque oppositis; *hyphopodiis capitatis* alternantibus vel unilateralibus, 15–30 μ longis; *hyphopodiis mucronatis*, oppositis vel unilateralibus, 8–9 μ diam.; *setis* nullis; *peritheciis* globosis, 150–200 μ diam.; *ascis* 2-sporis, evanidis; *sporidiis* 4-septatis, ad septa constrictis, obtusis, 42–45 × 14–15 μ.

There have been no previous reports of any species of *Meliola* or its segregates on the genus *Buettneria*. On the Sterculiaceae reported species of the *Meliolineae* are distinctly different from *M. Buettneriae*, and in fact no species of *Irenina*, if this segregate is to stand, has been heretofore described for the family.

Meliola Cinnamodendri sp. nov.

Colonies dense, epiphyllous, often very numerous, circular at first, 2–4 mm. diameter, but coalescing to form a more or less uniform "sooty mold-like" covering over the leaf blades, not producing spots or discoloration of host tissue; *hyphae* dark brown, straight, branching commonly opposite, approximately at right angles, 7–9 μ diameter; *capitate hyphopodia* alternate, very rarely opposite, set at right angles to the hyphae, 18–24 μ long; *stalk cell* 4–9 μ long, 6–7 μ diameter, cylindrical; *head cell* ovoid, straight or curved, 12–15 μ long, 10–12 μ diameter; *mucronate hyphopodia* opposite or unilateral, 15–21 μ long, 7–9 μ diameter at point of attachment, tip straight or angled; *mycelial setae* erect or slightly curved, very numerous, 7–10 μ diameter, 135–275 μ long, uniformly dark brown, with 1-many teeth up to 30 mm. long or with 2–3 branches, each in turn subdivided into 2-several teeth; *perithecia* scattered uniformly through the colonies, somewhat verrucose, globose to globose depressed, 150–200 μ diameter; *asci* evanescent; *spores* 4-septate, rarely 3, ends obtusely rounded, deep brown, straight, constricted at the septa, 48–54 × 19–21 μ.

Formula under the Beeli system 3131. 5331.

On living leaves of *Cinnamodendron axillare* Endl. ex Walp. (Canellaceae), Viçosa, Minas Gerais, Brazil, A. S. Muller, *622* (Type), June 30, 1933.

Coloniis epiphyllis, 2–4 mm. latis, atris, confluentibus et irregularibus; *hyphis* atris, 7–9 μ crassis; *hyphopodiis capitatis* alternantibus, 18–24 μ longis, 10–12 μ latis; *hyphopodiis mucronatis* oppositis vel unilateralibus, 15–21 μ longis; *setis* mycelialibus numerosis, 7–10 μ crassis, 135–275 μ longis, rectis vel curvatis, 1-multis dentis, 5–30 μ longis, vel 2–3 furcatis denticulatis; *peritheciis* atris, globosis, 150–200 μ diam.; *ascis* evanidis; *sporidiis* 4-septatis, obtusis, ad septa constrictis, 48–54 × 19–21 μ.

Only one other species of *Meliola* has been reported heretofore on any member of the Canellaceae, *M. Thouiniae* Earle on *Winterania canella* L. in Puerto Rico. This latter species differs from *M. Cinnamodendri* in having unbranched setae, both alternate

and opposite capitate hyphopodia and smaller perithecia and spores.

Asterina Davillae sp. nov.

Colonies amphigenous, irregular to nearly circular, 1–4 mm. diameter, sometimes coalescent to form irregular patches over much of infected leaf blade, non-spot forming; *hyphae* medium brown, branching opposite or alternate and often at right angles, 3–4.5 μ diameter; *hyphopodia* opposite or alternate, one celled, sessile, or occasionally short stalked, ovate or less often lobed to irregular, 5–9 × 5–6 μ; *thyriothecia*, with scanty basal membrane, 150–200 μ diameter; *asci* oval to nearly globular, 4-spored, paraphysate; *spores* deep brown, 1-septate, deeply constricted at septa, 15–17 × 7–8 μ, one cell slightly larger; *conidia* not noted.

On living leaves of *Davilla rugosa* Poir, (Dilleniaceae), Viçosa, Minas Gerais, Brazil, A. S. Muller *583* (Type), June 4, 1933.   No previous records of *Asterina* on the genus *Davilla* have been found. Species on other genera of the Dilleniaceae differ in spore size, presence of conidia and in other morphological characters.

> *Maculae* nullae; *coloniis* amphigenis, irregularibus vel suborbicularibus, dein plus minus confluentibus et effusis; hyphis fuscis, ramis oppositis vel alternantibus, 3–4.5 μ diam.; *hyphopodiis* oppositis vel alternantibus, continuis, sessilibus, lobatis vel irregularibus, 5–9 × 5–6 μ; *thyriotheciis* 150–200 μ diam.; *ascis* 4-sporis, paraphysatis; *sporidiis* fuscis, 1-septatis, constrictis, 15–17 × 7–8 μ; *conidiis* non visis.

Asterina Mulleri sp. nov.

Colonies epiphyllous, non-spot forming, irregular to more or less circular, development sparse, black, 3–5 mm. diameter; *hyphae* branching sparsely, deep brown, 3–4 μ diameter; *hyphopodia* alternate or unilateral, 2-celled, up to 12 μ long; *stalk cell* cylindrical 2–5 μ long, 3–3.5 μ wide; *head cell* subglobular or pyriform, 2–3 lobed to irregular, at times bent at right angles to stalk cell, 4–8 μ long; *thyriothecia* few, irregularly scattered, 100–180 μ diam., circular, basal membrane scanty; *asci* subglobular, evanescent; *spores* deep brown, two celled, deeply constricted at septa, both ends broadly rounded, 14–18 × 7–9 μ.

On living leaves of *Passiflora speciosa* Gardn. (Passifloraceae), Viçosa, Minas Gerais, Brazil, A. S. Muller *790* (Type), May 20, 1934.   Differs from other species of the genus on the Passifloraceae in its stalked two-celled hyphopodia.

Maculis nullis; *coloniis* epiphyllis, plus minus orbicularibus, nigris, 3–5 mm. diam.; *hyphis* 3–4 μ diam; *hyphopodiis* alternantibus vel unilateralibus, 1-septatis, 8–12 μ longis, subglobosis vel lobatis; *thyriotheciis* paucis, orbicularibus, nigris, 100–180 μ diam.; *sporidiis* 1-septatis, ad septa constrictis, 14–18 × 7–9 μ.

Prillieuxina Cinchonae sp. nov.

Fungus colonies hypophyllous, circular, up to 1 cm. in diameter, often appearing in series along secondary veins and coalescing to form linear areas 2–6 cm. long, extending from margin to midrib, black; *hyphae* abundant, thin, tortuous, anastomosing, medium to light brown, 3–3.5 μ diameter, remotely septate; *hyphopodia* none; thyriothecia scattered, few to many, hemispheric-lenticular, 150–300 μ diameter, occasionally elongated, 100–350 μ, dehiscing by irregular lobes at maturity; *asci* subglobose to broadly ovate, 30–45 × 25–35 μ, 8-spored; *paraphyses* none; *spores* conglobate, medium brown, 2-celled, constricted at septa, 24–27 × 12–15 μ, upper cell somewhat wider and more rounded at top than the lower.

On living leaves of *Cinchona pubescens* Vahl (Rubiaceae), Otto Reinking, San Carlos de Buena Vista, near Zapote, Costa Rica, May 20, 1943. Type, Myc. Coll. *71382.* Portions of the type collection deposited in the Farlow, New York Botanical Garden and University of Michigan herbaria.

Hypophylla, plagulas 1 cm. latas formans; *mycelio* anastomosanti 3–3.5 μ crasso; hyphopodiis nullis; *thyriotheciis* hemisphaerico-lenticularibus, 150–300 μ diam.; *ascis* subglobosis usque ovatis, aparaphysatis, 30–45 × 25–35 μ, octosporis; *sporis* medio 1-septatis et constrictis, fulvis, 24–27 × 12–15 μ.

Dr. Otto A. Reinking found this fungus in abundance on a tree of *Cinchona pubescens* growing in the forest near commercial plantings of *Cinchona*. He notes that it was causing not only definite leaf spots but discoloration (reddening) of infected leaves which were falling prematurely. The fungus is of no little interest because of the relation of its host to important economic species and the possibility of its transfer to them.

No record has been found of any similar fungus on the genus *Cinchona*. Two species of *Prillieuxina*, *P. distinguenda* (Syd.) Ryan and *P. Burchelliae* (Doidge) Ryan, reported on other genera of the Rubiaceae, are clearly distinct by virtue of spores not over half the size of those of the *Cinchona* fungus.

Seynesia brosimicola sp. nov.

Producing definite, more or less circular spots, 2–3 mm. in diameter, light reddish brown in color (near Japan rose of Ridgway), often very numerous and uniformly distributed over entire leaf blade with corresponding discolored areas beneath; *free mycelium* none; *ascomata* circular to irregular, dull black, epiphyllous, relatively few in number (2–12) per spot, 140–160 μ in diameter when mature with varying numbers of smaller immature ones intermingled, at maturity splitting at the center into 3–7 lobes; *asci* ovate to nearly globular, few in number, mostly 8-spored, 42–48 × 28–32 μ; *spores* medium brown in color, 22–25 × 10–14 μ, 2-celled, strongly constricted at septa, often breaking apart at maturity, one cell slightly longer and wider than the other; *no paraphyses* noted; *conidia* not present.

On living leaves of *Brosimum discolor* Schott, (Urticaceae) Ana Florencia, State of Minas Gerais, Brazil, A. S. Muller *633* (Type), June 21, 1933. No previous records have been found of the occurrence of *Seynesia* on any member of the Urticaceae.

Maculis amphigenis, fuscis, circularibus, 2–3 mm. diam.; *mycelio* nullo; *peritheciis* epiphyllis, atris, circularibus vel irregularibus, 140–160 μ diam., stellatim dehiscentibus; *ascis* ovato-globosis, octosporis, 42–48 × 28–32 μ; *sporidiis* brunneis, valde constrictis, levibus, 22–25 × 10–14 μ; *conidiis* non visis.

Micropeltella Mulleri sp. nov.

Thyriothecia epiphyllous, without spots, numerous, evenly scattered over leaf blades, circular, slightly raised at the center, with circular ostioles, deep blue-green with white margins, which disappear with age, 500–800 μ diam.; *asci* broadly clavate, 75 × 30 μ, sessile, 8-spored, aparaphysate; *spores* 3–7-septate, hyaline, straight, deeply constricted at septa and separating at septa when mature, 30–50 × 4–7 μ; *end cell* 7 × 9 μ, obtusely rounded.

On living leaves of *Coffea arabica* L., (Rubiaceae) Viçosa, Minas Gerais, Brazil, A. S. Muller *219* (Type), Sept. 24, 1900.

Thyriotheciis epiphyllis, sine maculis, numerosis, circularibus, atro-coeruleis, 500–800 μ diam., cum ostiolis circularibus; *ascis* aparaphysatis, late clavatis, sessilibus, octosporis, 75 × 30 μ longis; *sporidiis* hyalinis, rectis, superne late rotundatis, valde constrictis, 3–7 septatis, 30–50 × 4–7 μ.

Micropeltis coffeicola P. Henn. from Guatemala, which would appear from its description to belong in *Micropeltella* as now constituted, differs in its smaller thyriothecia, asci and spores.

Mycosphaerella Castillae Stevenson & A. J. Watson, sp. nov.

Perithecia epiphyllous, black, numerous, innate to erumpent, ostiolate, aparaphysate, 90–150 µ long, 75–114 µ diameter; *asci* clavate to subclavate, 8-spored, 35–65 × 4–12 µ; *spores* clavate to cylindrical, hyaline, straight or slightly curved, biseriate to irregularly arranged, ends obtuse, uniseptate, hyaline, 16–23 × 3.5–6 µ.

On living leaves of *Castilla costaricana* Liebm. (Urticaceae), Speedway Estate, Cairo, Costa Rica, R. C. Lorenz *3071* (Type) (Rubber Investigations), Sept. 14, 1940.

Maculis angulosis, amphigenis, anguste atro-marginatis, intus sordidis, infra brunneis, 4–12 mm. diam.; *peritheciis* epiphyllis, nigris, primum immersis, demum plus minusve emergentibus, 75–114 µ diam.; *ascis* clavatis vel subclavatis, aparaphysatis, 35–65 × 4–12 µ; *sporidiis* clavatis vel cylindraceis, rectis vel parum curvulis, uniseptatis, hyalinis, 16–23 × 3.5–6 µ.   .

This fungus produces numerous striking white spots on the upper leaf surfaces with definite narrow deep brown borders, vein limited, irregular to angular, up to 12 mm. in diameter, reddish brown beneath.   No previous records of the occurrence of a *Mycosphaerella* on *Castilla* have been found.

Erikssonia Protii E. K. Cash, sp. nov.

Leaf spots cream-buff to deep olive buff (Ridgway), subcircular or irregular, limited by veins, 2–15 mm. in diameter, evident on both surfaces; *stromata* hypophyllous, thickly and evenly distributed over the spots, black, rough, stellate, carbonaceous, brittle, uniloculate, 0.2–0.5 mm. in diameter, arising from beneath the epidermis, soon appearing superficial with the base only slightly sunken in the epidermis, readily breaking off and leaving a black circle at the point of attachment, laterally elongated into 4–6 horn-like projections which radiate from the center; *single locule* deeply immersed in the center of the stroma, subglobose, 150–200 µ in diameter, with inconspicuous, conical ostiole, wall not differentiated from the stroma; *asci* cylindrical, acute at the apex, long-pedicellate, 125–150 × 8–11 µ; *paraphysoids* short, hyaline, filamentous; *ascospores* uniseriate, hyaline, oblong-ellipsoid, granulose, often guttulate near the ends, 12–15 × 5–7 µ.

On living leaves of *Protium asperum* Standl. (Burseraceae), Fruit Dale Dam, Almirante, Panama, Aug. 28, 1940, R. C. Lorenz *3070* (Type).   Host det. P. C. Standley.   Portions of the type collection deposited in the Farlow, New York Botanical Garden and University of Michigan herbaria.

Stromata hypophylla in maculis alutaceis distributa, atra, carbonacea, uni-loculata, 0.2–0.5 mm. diam., lateraliter in processibus corniformibus e centro radiantibus stellatim producta; *loculi* in quoque stromate singuli, immersi, subglobosi, 150–200 μ in diam.; *asci* cylindrici, apice angustati, longe pedicellati; *ascosporae* uniseriatae, hyalinae, oblongo-ellipsoideae, granulosae, 12–15 × 5–7 μ.

The genus *Erikssonia*, originally named by Penzig and Saccardo as a member of the Hysteriaceae, was later redescribed by Theissen and Sydow (Ann. Myc. **15**: 315, 1917) as belonging to the Sphaeriaceae. In a more recent discussion (Ann. Myc. **29**: 387–390, 1931), based on an examination of type material of *E. pulchella* Penz. & Sacc., type of the genus, Petrak placed the genus in the Bagnisiopsidaceae, considering it to be a uniloculate *Bagnisiopsis*, characterized by radiating lateral projections of the stroma. The structure of the fungus on *Protium* is very similar to that described by Petrak for *Erikssonia* and it is therefore referred to that genus, although specimens were not available for comparison. It appears to be specifically distinct from the two known species: *E. pulchella* Penz. & Sacc., described on the leaf of an unknown plant from Java, and *E. Spatholobi* Theissen & Sydow on *Spatholobus apoensis* Elmer, collected in the Philippine Islands. Only hyaline spores have been found in *E. Protii*, but it is possible that they may become brown when fully mature, since those in the type species are said to remain hyaline for some time.

Patellea Hesperozygiae E. K. Cash, sp. nov.

Apothecia hypophyllous, superficial and easily detached from the host, scattered in a thin, dark subiculum, sessile, fleshy to horny, flat-disciform, 100–250 μ in diameter, plane or slightly convex when moist, the upturned margin conspicuous when dry, exterior furfuraceous, fuscous-black, hymenium concolorous; *asci* broad-clavate to pyriform, short-pedicellate, apex broadly rounded with wall much thickened, 8-spored, 22–30 × 10–13 μ; *spores* irregularly 2–3-seriate, clavate, 1-septate, slightly constricted, the upper cell broader than the lower, 9–10 × 2.5–3 μ; *paraphyses* exceeding the asci, filiform, thickened and branched at the apex, conglutinated in a brown mazaedium; *hypothecium* pale brown, plectenchymatous; *cortex* black, dense, roughened, particularly at the margin, by clumps of short, thick, black cells; *hyphae* of the subiculum fine, 1–1.5 μ diameter, thin-walled, pale grayish-brown, branched and interwoven.

On leaves of *Hesperozygia nitida* (Benth.) Epling (Labiatae), Araponga, Viçosa, Brazil, Nov. 1, 1934, A. S. Muller *856* (Type).

Apothecia hypophylla in subiculo hypharum tenuium pallide griseobrunnearum dispersa, patelliformia margine recurvato, fusco-nigra, furfuracea, 100–250 μ diam.; *asci* clavato-pyriformes, octospori, 22–30 × 10–13 μ; *ascosporae* 2–3-seriatae, clavatae, 1-septatae, leniter constrictae, cellula superiore crassiore, 9–10 × 2.5–3 μ; *paraphyses* filiformes, apice incrassatae et ramosae, in mazaedium brunneum conglutinatae.

This species is similar in dimensions of apothecia, asci and spores to *Patellea cyanea* (Ellis & Mart.) Sacc., described on leaves of *Quercus* from Florida (Jour. Myc. 1: 97, 1885). The apothecia and subiculum of the latter, however, are steel blue or indigo blue, not brown, and the apothecia are less rough in the specimen examined (Ellis, N. Am. Fungi *1781*). *P. Loranthaceae* P. Henn. on leaves of Loranthaceae in Brazil differs in larger dimensions, according to the description.

Phleospora Prosopidis sp. nov.

Spots none; *pycnidia* amphigenous, but usually more abundant on the exposed surfaces of each leaf, petiolicolous, and on tips of twigs, numerous, scattered, immersed, dark, 175–275 μ diameter, 200–225 μ deep, opening by a wide pore (100–125 μ); *conidia* linear, obtusely rounded at one end, more acute at the other, straight or curved, hyaline, not constricted at septa, distinctly median one-septate, more rarely non- or 2–3-septate, 30–45 × 3–4 μ, extruding in pale pink translucent masses, surrounded by the dark margins of the pycnidia.

On living leaflets, petioles and young twig tips of *Prosopis pubescens* Benth. (*Strombocarpa pubescens* [Benth.] A. Gray) Shoshone, Amargosa Valley, California, Frederick V. Coville and M. French Gilman *455* (Type), April 26, 1932.

Maculis nullis; *pycnidiis* amphigenis, petiolicolis et ramicolis, innatis, numerosis, 175–275 μ diam.; *conidiis* linearibus, rectis vel curvulis, non constrictis, hyalinis, 1-septatis, rare 2–3-septatis, 30–45 × 3–4 μ.

This fungus is placed in this somewhat doubtful genus for want of a better place to pigeon-hole it. Taking the genus in the sense of Grove (British Stem and Leaf Fungi 1: 431–436, 1935), however, it fits very well. No record of a similar fungus on any of the- leguminosae has been found. *Phleospora Caraganae* Jacz.

produces definite spots on leaf blades and is characterized by smaller conidia.

Clasterosporium Polypodii sp. nov.

Hyphae scanty, prostrate, septate, sparingly branched, superficial on pinnae or twining about the trichomes, deep brown, 3–4 μ diameter; *conidia* scattered, erect, straight, deep brown, 8–20 septate, not constricted at septa, 6–8 μ diameter, 50–250 μ long, basal and apical cells narrowed.

On living pinnae and trichomes of *Polypodium nanum* Feé, (Polypodiaceae), Bolivar, Rio Paragua, Salto de Auraima, Venezuela, E. P. Killip *37346*a (Type), April 10, 1943.

Hyphis prostratis, septatis, fuligineis, parce ramosis, in pinnis superficialibus, vel trichomata circumtorquentibus, 3–4 μ diam.; conidiis rectis, fuligineis, 8–20 septatis, ad septa non constrictis, 6–8 μ diam., 50–250 μ longis.

BUREAU OF PLANT INDUSTRY STATION,
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MOLDS IN RELATION TO ASTHMA AND VASOMOTOR RHINITIS

A REVIEW

Marie Betzner Morrow [1] and Edwin Palmer Lowe [2]

INTRODUCTION

Two concepts of asthma and vasomotor rhinitis are generally prevalent. Some claim that these diseases are the result of nasal pathology and should be treated as such: others, that allergy is the only basis to be considered. In a discussion of these Vaughan (**1939**) points out that the extrinsic case is typically allergic. The exciting cause is contact with some specific allergen to which the individual is sensitized, and with which he comes in contact through the skin, or the respiratory or digestive tracts, and from some source outside the body. This paper is confined to a discussion of those molds which are associated with inhalant respiratory allergy. The assumption of molds having etiological significance in asthma and vasomotor rhinitis seems to have arisen from the investigations of the relationship between these diseases and house dust and climate.

BEGINNINGS OF MOLD ALLERGY

In 1924 Van Leeuwen found that asthma was more prevalent in the humid regions of Holland, and attributed its cause to "miasmata" or "climate allergens," since he was unable to establish positive identity. A year later (**1925**) he reported the relief of patients' symptoms by the use of filtered air. He also found that changing a feather sensitive patient to kapok pillows failed to relieve her symptoms, and discovered that the new sensitivity was due to the molds developing on the kapok. Having found fungus allergy in as high as fifty per cent of Dutch asthmatics, the molds being principally *Mucor*, *Penicillium*, and *Aspergillus*, Van Leeu-

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wen concluded that saprophytic fungi were possibly the unknown "climate allergens."

Earlier, in America, Cook (1922) had called attention to house dust as a cause of bronchial asthma. He was never able to determine the exact identity of its active ingredient, although he did find that high temperatures would diminish its activity. Consequently, he concluded that house dust contained an unknown substance which had antigenic action. Leopold and Leopold (1925) working in Philadelphia found that filtered air in a dust-free room would relieve the asthmatic symptoms of dust sensitive patients. It is interesting to note that these results, independent and in the same year, tended to corroborate the findings of Van Leeuwen. Actually, the first report of inhalant fungus allergy in North America was that of Cadham (1924), who described three cases of asthma from wheat rust (*Puccinia graminis* Pers.).

In 1928 Cohen in this country found cotton and kapok-stuffed pillows, mattresses, and furniture to be sources of house dust antigen. A year later he reported asthmatic patients, specifically sensitive to molds isolated from these packings, clinically free from symptoms when the offending articles were removed. In Germany, Hansen (1928) found that fifteen per cent of his asthmatics reacted positively to skin tests with one or more of the *Aspergilli* and *Penicillia* cultivated from their environment, and in several cases he was able to reproduce symptoms by means of inhalation tests. Also in 1928 Jimines-Diaz and Sanchez Cuenca demonstrated that house dust sensitivity in Spain was often due to molds.

SURVEYS OF AIR-BORNE MOLDS

Blackley, as early as 1873, mentioned the presence of smut spores on pollen slides, and even reported severe reactions to the inhalation of *Chaetomium* and *Penicillium* spores in his own case. In 1923 Stakman and associates reported an abundance of mold spores in the air up to altitudes of 11,000 feet. Blackley mentioned his findings in connection with a study of possible pollen allergy, whereas Stakman was investigating the air distribution of plant pathogens. Neither of these workers, it seems, considered the possibility that the presence of mold spores in the air might be connected with inhalant allergy.

Since 1930 increasing attention has been given to inhalant mold allergy in the United States.   First, it was necessary to determine what molds were air-borne, and what sensitivity was exhibited toward them.   To determine the former, surveys were undertaken.   Patterson and Gay (1932) reported *Alternaria* and *Hormodendrum* in Baltimore during the summer of 1930.   In 1932 Balyeat and associates, working in Oklahoma, and using both slide and plate methods, isolated fifteen species, only two genera being represented, *Aspergillus* and *Penicillium*.   They found few patients sensitive to molds, but their conclusion that molds were not very allergenic is open to question, since they sterilized their pellicles with heat prior to extraction.   They attributed the lack of allergenicity to the small size of mold spores.   In the same year Jimines-Diaz and workers (1932) observed mostly *Mucor, Penicillium*, and *Aspergillus, Alternaria* less frequently, on plates exposed throughout the maritime provinces of Spain.   In 1934, Prince, Selle, and Morrow correlated high plate counts and increased symptoms in asthmatic patients with the winds blowing from the swampy regions north of Galveston, Texas, during the winter.

Airplanes were used in three surveys in 1935.   Using this means to expose slides MacQuiddy (1935) found mold spores up to 7000 feet, whereas pollen was not recovered above 3000 feet.   Meier and Lindberg (1935) reported spores of *Macrosporium, Cladosporium, Leptosphaeria, Mycospharella, Trichothecium, Heliosporium*, and *Uromyces* well north of the Arctic Circle.   Using a special spore counter attached to the plane, Procter (1935) surveyed Boston and vicinity and found spores to 20,000 feet. *Aspergillus, Penicillium, Rhizopus, Mucor, Oospora, Monosporium, Macrosporium, Tilachlidum* and *Fusarium* were isolated.   In 1936 Stevens not only collected spores of *Rhizopus, Aspergillus niger* van Tieghem, *Aspergillus fumigatus* Fresenius, *Penicillium cyclopium* Westl., and *Macrosporium* between 36 and 70,000 feet, but found that spores taken into the stratospheric environment would germinate when returned to their normal habitat.

From 1936 an increasing number of surveys were reported from many parts of the United States.   Feinberg (1936, 1937, 1942) over a five-year period in Chicago collected spores by the plate

method and observed seasonal aspects in the case of *Alternaria* and *Hormodendrum*. Highest counts occurred there in the summer. Durham (**1937**) used the greased slide method to determine the prevalence of *Alternaria* in the United States and concluded that the *Alternaria* belt corresponded roughly to the wheat belt. Prince and Morrow (**1937**) observed high plate counts in the winter along the Texas Coast. *Aspergillus, Monilia, Penicillium, Helminthosporium, Cephalosporium,* and *Spondylocladium* were encountered most frequently. Later Durham (**1938**), again using the slide method, found the geographical distribution of *Hormodendrum* similar to that of *Alternaria*. In a survey of the Pacific Northwest Schonwald (**1938**) observed *Alternaria, Aspergillus, Hormodendrum, Trichoderma, Mucor,* and *Rhizopus*; and Pratt (**1938**) reported *Alternaria, Hormodendrum, Aspergillus, Penicillium,* and *Chaetomium* from Boston.

In 1939 studies of air-borne molds were made by the plate method in Havana, Cuba, by Cadrecha and Quintera, and by the slide method by Coles in Iowa, and Wittich in Minnesota. Wittich emphasized the seasonal aspects of smuts. Loose smuts occurred in June and July, stinking smuts in August and September, and corn smuts in the fall. Craige (**1940**) also reported high spore production and aerial dissemination of cereal rusts. Although Bigg and Sheldon (**1939**) found mold spores continuously at Ann Arbor, Michigan, seasonal peaks of *Alternaria* and *Hormodendrum* occurred in the spring and fall. Whereas Stroh (**1940**) concluded from his study of Seattle and vicinity that the mold incidence there was low, the average counts on his plates were comparatively high and included *Hormodendrum, Alternaria, Aspergillus, Cephalosporium, Cladosporium, Monilia, Mucor, Penicillium, Trichoderma,* and *Rhizopus*. Dimond and Thompson (**1941**) reported *Alternaria, Hormodendrum, Dematium (Pullularia)* de Bary & Low, *Aspergillus, Penicillium,* yeast-like forms, *Sepedonium* and others at New Haven, Connecticut, seasonal variation being observed for the first two. Waldbott (**1941**) exposed plates daily for a year at Detroit and observed a large number of forms. *Alternaria* and *Monilia* showed definite seasonal increase during summer and fall. Durham extended his earlier studies to Alaska in 1941, and found that rusts made up two

thirds of the total mold counts, but the total counts were considerably lower than those in the United States. *Hormodendrum, Alternaria, Penicillium, Phoma, Mucor, Fusarium, Monilia,* and *Aspergillus* were observed by Cohen (**1942**) at Buffalo, New York, throughout 1940. Seasonal variation was noted for most of these.

Working since 1938, Morrow, Lowe, and Prince have found molds widely distributed throughout Central and Southwestern United States, and although a large number of species have been encountered, certain ones tend to occur as dominants. Total counts have been found to be more uniform throughout the year in the South. The results would seem to indicate a seasonal rather than a regional trend in the case of certain dominants, as *Alternaria, Hormodendrum,* and *Fusarium;* neither seasonal nor regional trends being apparent in others, as *Aspergillus* and *Penicillium;* furthermore, a particular species, as *Pullularia pullulans* Berkh., not recognized as a dominant, may occur as a "shower" and make up a significant fraction of the total count.

EVIDENCE FOR MOLD ALLERGY

What is the accumulated evidence that molds behave antigenically?

Cadham (**1924**) established wheat rust (*Puccinia graminis* Pers.) as the causative agent of asthma; Van Leeuwen found fungus allergy in fifty per cent of his asthmatic patients; and fifteen per cent of Hansen's patients in Germany were sensitive to molds cultivated from their environments. Diaz's group in Spain (**1932**) concluded that true cases of climatic asthma were usually coastal, due to the abundance of fungi in the air, and secured successful results with mold therapy. Ellis (**1933**) correlated the high incidence of asthma in Port Sudan with the profuse occurrence of mold spores during the damp weather. Patients were found sensitive, and specific mold desensitization resulted in improvement.

Prince, Selle, and Morrow (**1934**) found a high percentage of patients sensitive to molds in the group tested in Texas, and the success secured with mold therapy indicated that fungi had a definite role in the disease. Feinberg (**1936**) concluded that seasonal hay fever due to molds was a definite clinical entity, since a

selected group of patients, whose seasonal symptoms corresponded to the maximum period of mold occurrence, was found sensitive and obtained relief when treated with mold extracts. Twenty patients whose histories suggested mold allergy were found sensitive by means of skin tests by Brown (1936) in Washington, D. C., and satisfactory results from desensitization with proper extracts were secured. He concluded that fungi were definite allergens and must be considered along with other active substances, as pollen, in the causation of respiratory allergic conditions. In Los Angeles, Lamson and Rogers (1936) found 12% of 1259 patients positive to skin tests.

From 1936, cases involving specific sensitivity to a single species were reported more frequently. The case of a druggist whose violent asthmatic attacks were induced by taka-diastase was reported by Leopold (1936). The clinical observations were substantiated by strongly positive skin reactions to *Aspergillus Oryzae* Cohn. Bernton and Thom (1937) reported four cases of respiratory allergy giving positive skin reactions to a saprophytic *Cladosporium*, and symptoms were relieved in three cases by specific desensitization. A case of asthma due to grain smut was reported by Wittich and Stakman (1937). The patient gave marked skin reactions to grain smut found in his sputum, and subsequent desensitization with smut extracts brought relief. Rackemann and associates (1938) in Boston found a high degree of specificity in the sensitivity of four patients to the plant pathogen, *Cladosporium fulvum* Cooke.

Ninety cases sensitive to molds and to pollens were reported by Feinberg in 1937. Treatment with molds was instituted in sixty cases with satisfactory results in most instances. Prince and Morrow (1937) found 36 of 46 patients mold sensitive, and in twenty of twenty-one cases satisfactory results were secured with mold therapy. Vander Veer (1937) found sixteen per cent of eighty patients in New York City sensitive. Twelve cases of respiratory mold allergy sensitive to three molds and yeasts were reported from Ohio by Harris (1938). Mold therapy produced good results in seventy-five per cent of the cases. In Boston, Pratt (1938) found that the most positive skin tests and the best results in mold treatment were secured with *Alternaria*.

In the Pacific Northwest, Schonwald (1938) found that 145 of 150 cases, with histories suggesting mold allergy, reacted positively to mold tests, and that seventy-seven per cent of 86 cases responded to mold treatment.　Prince (1939) found molds acting as minor allergens in a study of 150 cases emphasizing non-pollen factors, particularly in the summer and fall.　Mold sensitivity due to the four molds most commonly encountered on the exposure plates was reported from Cuba by Cadrecha and Quintera (1939).　Thirty-six per cent of sixty patients skin tested by Rackemann (1939) in Boston reacted positively.　Halpin (1939) found twenty-eight per cent of seventy-one seasonal hay fever patients in Iowa sensitive, principally to two genera, *Alternaria* and *Hormodendrum*.

Harris (1939) found that sensitivity to grain dust containing smut and other mold spores was apparently due to the grain smut rather than the molds, and in a further study that all the grain smuts did not have a common antigenic factor.　Of 105 cases of respiratory allergy sensitive to smuts and mold fungi twenty-three per cent was reported by Wittich in Minnesota (1939), of which eight cases were primary smut allergics.　Later (1940) Wittich reported that grain dust sensitivity was due principally to the biologic components of the dust, and that dust extracts would hyposensitize 85 per cent of the cases sensitive to the various dust allergens.　Although Cohen and workers (1939) presented evidence that the active principle of house dust was contained in linters rather than any of the other contaminants, Hampton and Stull (1940) are of the opinion that house dust contains an antigen different from any of the ordinary inhalant components of house dust including linters or molds.

Johnson grass smut was found to be a complicating factor, rather than the primary cause of allergy in Arizona by Phillips (1940) and five or more seasons of exposure were necessary for the development of symptoms.　Chobot and his associates (1940) found a definite percentage of 240 cases of inhalant allergy in New York City sensitive to molds, and subsequent tests indicated that this sensitivity was specific.　In clinical testing, Stroh (1940) reported only a few cases reacting to molds in the Seattle region. Hansel (1940) found many ragweed patients sensitive to molds in

St. Louis, and obtained more satisfactory results when mold therapy was added to the pollen treatment. It was Schonwald's (1941).observation that, although in some instances mold sensitivity was the primary cause of respiratory allergy, it appeared more often as a complicating factor.

Realizing that skin tests have not always proved reliable, Harris (1941) attempted to evaluate clinical sensitivity to molds by experimentally reproducing respiratory allergy in twenty-two patients reacting to *Alternaria*. By means of provocative and inhalation tests, he concluded that a typical mold history in the presence of a positive scratch test indicated mold allergy, and the nasal test outside of the mold season was a safe and reliable means of evaluating *Alternaria* sensitivity. Pennington (1941) studied 526 cases of allergy in Tennessee, and concluded that mold sensitivity was not uncommon, and must be taken into account in any complete study of the allergic state. Waldbott and associates (1941) tested 841 patients and found sixty-nine per cent to react to one or more molds. From their study they concluded that mold sensitivity occurred mostly as a complicating factor in multiple sensitive patients. Sixty-five out of a hundred patients reacted positively to a powdery mildew on oak in California, according to Alderson and Mason (1941).

This is the evidence. What is its significance?

Certain workers have been reluctant to recognize the concept that molds may, and, in many cases, do act as allergens. However, Vaughan (1939), of whom Durham (1942) speaks as having written the 'first comprehensive textbook treatment of fungus spores as allergens,' says:

"At the present time it appears safe to say that all of the requirements have been met. Positive skin reactions have been observed which can also be produced by passive transfer, indicating the presence of reagin. Relief has been obtained by avoidance, or by hyposensitization, and symptoms have been produced following subsequent exposure. The existence of the various molds in sufficient quantity has been demonstrated. The postulates of Cooke and Thomen appear to have been fulfilled."

THE POSTULATES OF COOKE (Vaughan, **1939**)

1. Sensitization must be demonstrated by one of the following:
    a. A positive local reaction, cutaneous or ophthalmic.
    b. The original allergic manifestation must be artificially re-
    produced at will on introduction of the substance, either
    inhaled, ingested or subcutaneously injected.
2. It must be shown that the individual has come into contact in
    some way with the suspected substance in order to permit it to
    act as an etiologic factor.

(The postulates are broadly acceptable, although it should be
borne in mind that 1-a often cannot be demonstrated.   This is
especially true in drug allergy, often also in food allergy.   Some-
times inhalant allergens fail to give reactions either on the skin
or conjunctiva, but do when introduced directly on the mucous
membrane of the nose.)

THOMEN'S FIVE POSTULATES (Vaughan, **1939**)

These postulates must be fulfilled before a pollen (mold) * can
cause epidemic or endemic respiratory allergy.
1. The pollen (mold) * must contain an excitant of hay fever.
2. The pollen (mold) * must be anemophilous.
3. It must be produced in sufficiently large quantities.
4. It must be sufficiently buoyant to be carried considerable dis-
    tances.
5. The plant (mold) * producing the pollen (spores) * must be
    widely and abundantly distributed.

(These postulates apply to epidemic or endemic hay fever,
obviously not sporadic hay fever, as in gardners, florists, etc.   As
with most postulates there are exceptions, but the exceptions
usually deal with the individual rather than large groups.)

MOLDS AS ALLERGENIC EXCITANTS

What are the molds, then, that have been established as in-
halant allergenic excitants?

Mucor, Penicillium, and *Aspergillus* were incriminated by Van
Leeuwen (**1925**), *Puccinia graminis* Pers. by Cadham (**1924**), and
Penicillium glaucum Link and certain *Aspergillus* species by

Extended to include molds.

Hansen (1928). Others were gradually added. An undesignated species of *Alternaria* was reported by Hopkins as early as 1930. Others have been reported by a great many workers (Pratt, 1938; Halpin, 1939; Harris, 1941). Many of these probably are *Alternaria tenuis* Nees, as this species is widely distributed in the United States. *Alternaria humicola* Oudem and *Alternaria Mali* Roberts were mentioned specifically by Brown in 1936 and the closely related species, *Phoma conidiogena* Schnegg by Benham in 1931.

A large number of Aspergilli have been reported: *A. candidus* Link, *A. clavatus* Desm., *A. conicus* Blochw., and *A. flavipes* Thom and Church (Brown, 1936); *A. flavus* Link (Van Leeuwen, 1925); *A. fumigatus* Fres. (Van Leeuwen, 1925; Bernton, 1930; Lamson, 1936; Brown, 1936); *A. glaucus* Link-group and *A. hortai* (Brown, 1936); *A. Oryzae* Cohn (Brown, 1936; Leopold, 1936); *A. nidulans* Eidam and *A. niger* Tieghem (Van Leeuwen, 1925; Brown, 1936; Lamson, 1936); *A. parasiticus* Speare and *A. terreus* Thom (Brown, 1936); and *A. Sydowi* Thom and Church (Prince, 1934). Among the Penicillia: undesignated *Penicillium* species (Van Leeuwen, 1925; Brown, 1936; Lamson, 1936); *P. chlorophaeum* Biourge, *P. chrysogenum* Thom, *P. cyclopium* Westl., *P. elongatum* Dierckx, *P. expansum* Thom, *P. italicum* Wehmer, *P. lanosum* Westl., *P. roqueforti* Thom, and *Citromyces* species (Brown, 1936). Among the Mucorales: *Mucor* species (Van Leeuwen, 1925; Cadrecha and Quintera, 1939); *M. plumbeus* Bon. (Flood, 1931; Lamson, 1936); *M. Mucedo* Bref. (Brown, 1936); and *Rhizopus* species (Conant et al, 1936); and *Absidia* (Waldbott et al, 1941).

Monilias and yeasts include *Monilia* species (Lamson, 1936); *M. albicans* Zopf. (Bernard, 1934); *M. sitophila* Sacc. (Brown, 1936; Prince, 1937); yeast species (Taub, 1932; Harris, 1938); bakers' and brewers' yeast, *Saccharomyces cereviseae* Hansen (Brown, 1936); and *Torula* (Waldbott et al, 1941).

Plant pathogens cited include maple bark fungus, *Coniosporium sorticola* (Towey et al, 1932); grain smuts (Brown, 1936; Harris, 1939; Wittich, 1939 & 1940); *Puccinia graminis* Pers. (Cadham, 1924; Wittich, 1940); and *Microsphaera Alni* Wint. (Alderson & Mason, 1941). A saprophytic *Cladosporium* (Bernton & Thom,

1937) and a tomato pathogen, *Cladosporium fulvum*, Cooke (Cobe, 1932), have also been reported.   Animal pathogens include *Trichophyton* species (Wise & Sulzberger, 1930), *T. gypseum* Bodin and *Epidermophyton inguinale* Sab. (Brown, 1936).

Other fungi reported include *Chaetomium* (Feinberg, 1936; Lamson, 1936); *Cephalothecium roseum* Cda. and *Dicoccum asperum* Lindau (Brown, 1936); *Trichoderma* (Prince, 1937; Schonwald, 1941); *Helminthosporium* (Feinberg, 1936; Prince, 1937); *Fusarium* (Feinberg, 1936); and certain unnamed molds from mildewed awnings (Nichol, 1931).

SOURCES OF THE ALLERGENIC MOLDS

By far the greater number of air-borne molds come from the out-of-doors.   Soil is perhaps the source of the greatest number. While the common forms (as *Penicillium*, *Aspergillus*, *Fusarium*, *Alternaria*, *Helminthosporium*, *Hormodendrum*, and *Mucorales*) are widely distributed, many of them flourish more or less locally and may be therefore sufficiently increased in a given environment, to cause definite sensitization.   For example, since mildew of textiles is due generally to *Aspergillus* or *Penicillium* introduced in raw material during the process of manufacture, or acquired during exposure to the air in damp environments, awnings, tents, draperies, window-shades, and even wallpaper and the canvas beneath it are exceptionally potent sources of mold growth in damp districts (Galloway & Burgess, 1937).   Upholstered furniture, expecially that containing kapok (Conant, 1936), and mattresses furnish excellent substrates for mold growth.   Raw cotton is very often contaminated.   It seems hardly a stretch of the imagination that the cheaper grades of cotton generally used in bedding or upholstery may contain much infested material from the raw product.

Wool may be a source of mold fungi, mostly *Penicillium* and *Aspergillus* (Burgess, 1934).   *Monilia sitophila* Sacc. is often found in bakeries and in many homes, and is quite potent as an allergen (Bernton & Thom, 1937).   Luggage, shoes or gloves, leatherbottom chairs, and other leather articles frequently become moldy (McLaughlin, 1932).   Natural silk is not immune from mold contamination; it seems to be more susceptible after

the finishing process than before it is degummed (Yendo, **1928**). Almost all food-stuffs are liable to fungus attack. Fresh fruits and vegetables are all subject to deterioration by molds. Foods in cold storage, either wrapped or unwrapped, are particularly likely sources of mold contaminants, and are a potential source of excitant to allergic individuals employed in markets, packing plants, etc.

Another important source of molds is plants, since many are infected with certain parasitic species of fungi. This source is often overlooked, for a large number of the fungous diseases are obligate parasites and cannot exist without their hosts. Rusts and smuts are probably the best-known plant pathogens to allergists, the smuts apparently being more antigenic than the rusts. Grain smuts in particular have been shown to be an important cause of asthma and hay fever in the wheat and corn belts (Wittich, **1939, 1940**). It seems quite probable that many other plant pathogens may also have etiological significance in inhalant respiratory allergy, and investigations on sources of antigenic molds should be extended to include these.

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BIBLIOGRAPHY

Alderson, V. G. & Mason, Lucile R. Powdery mildews as allergens. Calif. Western Medicine 5: 241–243. 1941.

Balyeat, R. M., Stemen, T. R. & Taft, C. E. Comparative pollen, mold, butterfly and moth emanation content of the air. Jour. Allergy 3: 227–234. - 1932.

Bernard, R. Sur les dermatoses professionnelles. Rev. Belge Sc. Med. 6: 401. 1934. Cited by Vaughan, W. T. Practice of Allergy. C. V. Mosby Co. St. Louis, Mo. P. 1037. 1939.

Bernstein, T. B. & Feinberg, S. M. Air-borne fungus spores. A five year survey of daily mold spore content of Chicago air. Jour. Allergy 13: 231–241. 1942.

Bernton, H. S. Asthma due to a mold—*Aspergillus fumigatus*. J. A. M. A. 95: 189–191. 1930.

Bernton, H. S. & Thom, C. The role of *Cladosporium*, a common mold, in allergy. Jour. Allergy 8: 363–370. 1937.

Bigg, E. M. & Sheldon, J. M. Air-borne fungus spore counts of Ann Arbor, Michigan. Univ. Hosp. Bull. 5: 43. 1939.

Blackley, C. H. Experimental researches on the cause and nature of *Catarrhus Aestivus* (hay fever or hay asthma). Bailliere, Tindall and Cox. London. 1873.

Brown, G. T. Hypersensitiveness to fungi. Jour. Allergy **7**: 455–470. 1936.

Burgess, R. Jour. Soc. of Duers Col. **50**: 138. 1934. Cited by Prince, H. E. and Morrow, M. B. Molds in the etiology of asthma and hay fever with special reference to the coastal areas of Texas. South. Med. Jour. **30**: 754–762. 1937.

Cadham, F. T. Asthma due to grain rusts. J. A. M. A. **83**: 27. 1924.

Cadrecha-Alvarez, J. & Quintera-Fossas, J. M. Investigations demonstrating the hourly variations of air-borne fungi in relation to meteorologic iufluences; role in certain asthma and rhinitis crises. Rev. Med. Cir. Habana **44**: 411–453. 1939.

Chobot, R., Dundy, H. & Schaffer, N. Relationship of mold reactions to clinical symptoms. Jour. Allergy **12**: 46–54. 1940.

Cobe, H. M. Asthma due to a mold. Jour. Allergy **3**: 389–391. 1932.

Cohen, M. B. & Rudolph, J. A. Jour. Lab. and Clin. Med. **13**: 1006. 1928. Cited by Cohen, M. B., Cohen, S. and Hawver, K. Further observations on the nature of the house dust antigen. Jour. Allergy **10**: 561–565. 1939.

Cohen, M. B., Cohen, S. & Hawver, K. Further observations on the nature of the house dust antigen. Jour. Allergy **10**: 561–565. 1939.

Cohen, V. L. The content of fungous spores in the air in Buffalo, New York. Abst. Jour. Bact. **1**: 115–116. 1942.

Coles, J. Pollen survey in Ames, Iowa in 1938. Jour. Iowa Med. Soc. **28**: 198. 1939. Cited by Feinberg, S. M. and Bernstein, T. B. Asthma and hay fever. Jour. Allergy **11**: 281–308. 1940.

Conant, N. F., Wagner, H. C. & Rackemann, F. M. Fungi found in pillows, mattresses, and furniture. Jour. Allergy **7**: 234–237. 1936.

Cooke, R. A. Studies in specific hypersensitiveness. IV. New etiologic factors in bronchial asthma. Jour. Immunology **7**: 147–162. 1922.

Craige, J. H. Aerial dissemination of plant pathogens. Proc. Sixth Pacif. Sci. Congr. 1939: 753–767. 1940.

Dimond, N. S. & Thompson, K. W. Air-borne fungi in New Haven, Connecticut: Record for the year September, 1940, to September, 1941. Yale Jour. Biol. and Med. **14**: 395. 1942.

Durham, O. C. Incidence of air-borne fungus spores. I. *Alternaria*. Jour. Allergy **8**: 480–490. 1937.

——. Incidence of air-borne fungus spores. II. *Alternaria, Hormodendrum* and rust spores. Jour. Allergy **10**: 40–49. 1938.

——. Atmospheric allergens in Alaska. Jour. Allergy **12**: 307–309. 1941.

——. Air-borne fungus spores as allergens. Pub. A. A. A. S. **17**: 32–47. 1942.

Ellis, D. The incidence of asthma in Port Sudan, with special reference to the influence of moulds. Guy's Hosp. Rep. **83**: 102. 1933. Cited by Brown, G. T. Hypersensitiveness to fungi. Jour. Allergy **7**: 455–470. 1936.

Feinberg, S. M. Seasonal hay fever and asthma due to molds. J. A. M. A. **107**: 1861–1867. 1936.

Feinberg, S. M. & Little, H. T. Studies on the relation of micro-organisms to allergy. III. A year's survey of daily mold spore content of the air. Jour. Allergy **7**: 149. 1936.

Feinberg, S. M.   Asthma and allergic rhinitis from molds.   Lancet **57**: 87–90. 1937.

Flood, C. A.   Observations on sensitivity to dust fungi in patients with asthma. J. A. M. A. **96**: 2094–2096.   1931.

Galloway, L. D. & Burgess, R.   Applied mycology and bacteriology.   Leonard Hill, Ltd.   London.   1937.

Halpin, L. J.   Respiratory allergy: Survey of 283 consecutive cases seen in office practice from July, 1937 to December, 1938.   Jour. Iowa Med. Soc. **29**: 439.   1939.   Cited by Feinberg, S. M. and Bernstein, T. B. Asthma and hay fever.   Jour. Allergy **11**: 281–308.   1940.

Hampton, S. F. & Stull, A.   Antigenic studies by the Dale test.   II. The antigenicity of house dust.   Jour. Allergy **11**: 109–129.   1940.

Hansel, F. K.   Hay fever: The value of daily atmospheric counts of pollen grains and mold spores in diagnosis and treatment.   Jour. Missouri Med. Assn. **37**: 241.   1940.   Abstract: Jour. Allergy **12**: 110.   1940.

Hansen, K.   Uber schimmelpilz-asthma.   Verhandl. Deutsch. Gesellsch. Inn. Med. **40**: 204.   1928.   Cited by Brown, G. T.   Hypersensitiveness to fungi.   Jour. Allergy **7**: 455–470.   1936.

Harris, L. H.   Molds as a cause of asthma.   Ohio State Med. Jour. **34**: 158–160.   1938.
Allergy to grain dusts and smuts.   Jour. Allergy **10**: 327–336.   1939.
The nature of the grain dust antigen: Crossed reactions to grain dusts and smuts.   Jour. Allergy **10**: 433–442.   1939.
Experimental reproduction of respiratory mold allergy.   Jour. Allergy **12**: 279–289.   1941.

Hopkins, J. G., Benham, R. W. & Kesten, B. M.   Asthma due to a fungus— *Alternaria*.   J. A. M. A. **94**: 6–10.   1930.

Jimenez-Diaz, C. & Sanchez-Cuenca, F.   Arch. Med. Cir. Espec. **29**: 284. 1928.   Cited by Jimenez-Diaz, C., Sanchez-Cuenca, B. and Puig, J. Climatic asthmas.   Jour. Allergy **3**: 396–403.   1932.

Jimenez-Diaz, C., Sanchez-Cuenca, B. & Puig, J.   Climatic asthmas.   Jour. Allergy **3**: 396–403.   1932.

Lamson, R. W. & Rogers, E. L.   Skin hypersensitivity to molds.   Jour. Allergy **7**: 582–589.   1936.

Leopold, S. S. & Leopold, C. S.   Bronchial asthma and allied allergic disorders.   J.A.M.A. **84**: 731–734.   1925.

Leopold, S. S.   Sensitivity to taka-diastase (*Aspergillus Oryzae*).   Jour. Allergy **7**: 594–596.   1936.

MacQuiddy, E. L.   Air studies at higher altitudes.   Jour. Allergy **6**: 123–127. 1935.

McLaughlin, G. B. & Rockwell, G. E.   Jour. Amer. Leather Assn. **17**: 375. 1932.   Cited by Prince and Morrow.   Molds in the etiology of asthma and hay fever with special reference to the Coastal Areas of Texas. South. Med. Jour. **30**: 754–762.   1937.

Meier, F. C., with field notes and material by Lindberg, C. A.   Collecting micro-organisms from the Arctic atmosphere.   Scientific Monthly **40**: 5–20.   1935.

Morrow, M. B., Lowe, E. P. & Prince, H. E.   Mold fungi in the etiology of respiratory allergic diseases.   I. A survey of air-borne molds.   Jour. Allergy **13**: 215–226.   1942.

Nichol, E. S. & Durham, O. C. A pollen survey of Miami, Florida. South. Med. Jour. **24:** 947. 1931. Cited by Vaughan, W. T. Practice of allergy. C. V. Mosby Co. St. Louis, Mo. P. 1051. 1939.

Patterson, P. M. & Gay, L. N. The pollen content of the air and its relation to hay fever in Baltimore, Maryland during 1930. Jour. Allergy **3:** 282. 1932.

——. A study of clinical sensitivity to air-borne molds. Jour. Allergy **12:** 388–404. 1941.

Phillips, E. W. Time required for the production of hay fever by spores of a newly encountered fungus, Johnson grass smut. Jour. Allergy **12:** 24–27. 1940.

Pratt, H. N. Seasonal aspects of asthma and hay fever in New England, with special reference to sensitivity to mold spores. New Eng. Jour. Med. **219:** 782–786. 1938.

Prince, H. E., Selle, W. A. & Morrow, M. B. Molds in the etiology of asthma and hay fever. Texas State Jour. Med. **30:** 340–344. 1934.

Prince, H. E. & Morrow, M. B. Molds in the etiology of asthma and hay fever with special reference to the Coastal Areas of Texas. South. Med. Jour. **30:** 754–762. 1937.

Prince, H. E. Non-pollen factors simulating seasonal respiratory allergy. South. Med. Jour. **32:** 956–960. 1939.

Proctor, B. E. The microbiology of the upper air. I. Proc. Am. Acad. **69:** 315. 1934.   ⋅

——. The microbiology of the upper air. ⋅ II. Jour. Bact. **30:** 363–375. 1935.

Rackemann, F. M., Randolph, T. G. & Guba, E. F. The specificity of fungous allergy. Jour. Allergy **9:** 447–453. 1938.

Rackemann, F. M. Molds as a cause of hay fever and asthma.Tr. Am. Clin. Climat. A. (1937) **53:** 194. 1939. Cited by Feinberg, S. M. and Bernstein, T. B. Asthma and hay fever. Jour. Allergy **11:** 281–308. 1940.

Schonwald, P. Allergenic molds in the Pacific Northwest. Jour. Allergy **9:** 175–179. 1938.

——. Fungus allergies. Northwest Med. **40:** 17–20. 1941.

Stakman, E. C., Henry, A. W., Curran, G. C. & Christopher, W. N. Spores in the upper air. Jour. Agr. Res. **24:** 599–605. 1923.

Stevens, A. W. The scientific results of the world-record stratosphere flight. Nat. Geographic Mag. **69:** 693–712. 1936.

Stroh, J. E. Flora and pollen surveys of Seattle and vicinity. Northwest Med. **39:** 258–264. 1940.

Taub, S. J. Asthma due to yeast (by ingestion). Jour. Allergy **3:** 586–587. 1932.

Towey, J. W., Sweany, H. C. & Huron, W. H. Severe bronchial asthma apparently due to fungus spores found in maple bark. J. A. M. A. **99:** 453–458. 1932.

Vander Veer, A. Mold spores in asthma and hay fever. Jour. Allergy **8:** 277. 1937.

Van Leeuwen, W. S. Bronchial asthma in relation to climate. Proc. Royal Soc. Med. **17:** 19–22. 1924.

——. Klin. Wchnschr. **4:** 1294. 1925. Cited by Jimenez-Diaz, C. et al. Climatic asthmas. Jour. Allergy **3:** 396–403. 1932.

Van Leeuwen, W. S., Bien, Z., Kremer, W. & Varekamp, H. Ztschr. Immunitatsforsch. **44**: 1. 1925. Cited by Jimenez-Diaz, C. et al. Climatic asthmas. Jour. Allergy **3**: 396–403. 1932.

Vaughan, W. T. Practice of Allergy. C. V. Mosby Co. St. Louis, Mo. 1939.

Waldbott, G. L., Blair, K. E. & Ackley, A. B. An evaluation of the importance of fungi in respiratory allergy. J. Lab. Clin. Med. xxvi **10**: 1593–1599. 1941.

Wise, F. & Sulzberger, M. B. *Urticaria* and hay fever due to trichophytin (*Epidermophytin interdigitale*). J. A. M. A. **95**: 1504. 1930.

Wittich, F. W. & Stakman, E. C. Case of respiratory allergy due to inhalation of grain smuts. Jour. Allergy **8**: 189–193. 1937.

Wittich, F. W. Further observations on allergy to smuts. Lancet **59**: 382–388. 1939.

———. The nature of the various mill dust antigens. Lancet **60**: 418–422. 1940.

Yendo, Y. Abstract Esp. Sta. Rec. **58**: 392. 1928. Cited by Prince, H. E. and Morrow, M. B. Molds in the etiology of asthma and hay fever with special reference to the Coastal Areas of Texas. South. Med. Jour. **30**: 754–762. 1937.

NOTES AND BRIEF ARTICLES

MELANOPSICHIUM ON POLYGONUM AVICULARE

A species of *Melanopsichium* occurred very abundantly on this host in the Brooklyn Botanic Garden in July 1939. Attention was attracted to the smut by the occurrence of numerous areas here and there in the experimental field on a humid morning, as though some heavy machine oil had been spilled. However, examination revealed the presence of many plants of knot grass with the gall-like enlargements caused by this fungus. Large, hard, irregular, dark colored, firmly agglutinated, conspicuous spore masses, were well developed at the crown of the plant and numerous smaller ones were scattered along the creeping stem. In the following seasons additional specimens were collected, but in no case were they so abundant as in the first year.

Until recently only one species of this genus, *Melanopsichium austro-americanum* (Speg.) Beck was recognized, and has been recorded on various species of *Polygonum*. The only record on *P. aviculare* is from California. Recently, Hirschhorn (Nota d. Museo de La Plata (Bot. 32.) **6**: 147–151. 1941) and Zundel (Mycologia **35**: 164–184. 1943) have recognized two species and several varieties of the genus. The smut collected in the Botanic Garden belongs in the new species *M. pennsylvanicum* Hirschh., along with other collections from the Middle West to the East on various species of *Polygonum*.

The smut is widely distributed in the Mississippi Valley and is very common on Long Island. The usual hosts are the large, coarse species of *Polygonum*, particularly *P. lapathifolium* L. *P. virginianum* L. is also given as a host for *Melanopsichium pennsylvanicum*. This, however, may be questioned. In our herbarium there are two specimens labeled from Missouri as occurring on it. Apparently they both belong to the same collection made by C. H. Demetrio on Sept. 9, 1891. The host in both cases is probably *P. lapathifolium;* certainly it is not *P. virginianum*. It may be noted that both specimens consist of *Ustilago*

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utriculosa (Nees) Tul. in the ovaries of the individual flowers, as well as the larger, irregular masses of *M. pennsylvanicum.*—GEORGE M. REED.

THEKOPSORA HYDRANGEAE

In regard to the article on 'Morphology, Cytology, and Parasitism of Thekopsora Hydrangeae,' appearing in the *Journal of the Elisha Mitchell Scientific Society* **59**: 45–68, 1943, the author requests that the following correction be made. Due to a misinterpretation of a statement made by Dr. B. O. Dodge in his paper on 'Morphology and Host Relations of *Pucciniastrum americanum*,' *Journal of Agricultural Research* **24**: 885–906, 1923, the present writer indicated that Dodge had not observed the budding process and formation of spore stalks in the uredinia of *Thekopsora Hydrangeae.* However, upon further investigation of this paper, I have found that Dodge did believe that these processes occurred in older sori of the rust.

It should also be noted that Professor L. O. Overholts reported, in 1933, the occurrence of this rust on *Hydrangea radiata;* whereas, Arthur named only one species, *H. arborescens*, as the alternate host.—LINDSAY S. OLIVE.

THE GENUS LONGIA

A Latin diagnosis of *Longia* was omitted from the recent article in Mycologia **35**: 414, 1943. It is given here to fulfill the requirements of the International Code.

Longia gen. nov.

Fructificationes agaricoidea; pileo subgloboso, depresso-globoso vel crasso-convexo; superficie glabra vel scabrida; stipite superne in columellam crassam percurrentem procurrenti; gleba atra, lamelloidea, libera; velo annulum relinquente; sporis atris vel obscure brunneis, subglobosis vel ellipsoideis.—S. M. ZELLER.

ITHYPHALLUS MURRILLIANUS WEST

Since this species was published (Mycologia **33**: 48. 1941) quite a number of specimens have been collected about Gainesville, Fla., and critically examined in a fresh condition. The

spores vary from 3 μ to 6.5 μ in length and are 2–2.5 μ broad,—not sufficiently different from those of *I. rubicundus*, of which it appears to me to be only a pale form. It frequently happens that species which seem distinct when collections are few will be found to run together when our knowledge of them becomes more extensive. All the specimens of the above plant that have been brought to my attention have been determined by me as *I. rubicundus*. Mr. West's effort to do me honor is appreciated but I hardly think I deserve it.—W. A. MURRILL.

BOOKS ON FUNGI AND MOLDS

The Office of Alien Property Custodian has licensed, during the past several months, the reprinting of scientific and technical books, of enemy origin, which are not available in a quantity sufficient to meet the demands of the wartime operations of science and industry.

In this connection the Custodian has received several queries concerning the possibility of licensing the republication of significant and generally unavailable foreign works in the field of fungi and molds. Before a definite decision can be made, it is necessary for the Custodian to be informed about the extent of the need of such works and to receive suggestions of specific titles for consideration. This can be accomplished if suggestions of specific significant works in these fields are sent by individuals to the Office of Alien Property Custodian, Washington, D. C. These suggestions or any inquiries should be addressed to Howland H. Sargeant, Chief, Division of Patent Administration, Office of Alien Property Custodian, Washington, D. C.

CONSERVATION OF SCHOLARLY JOURNALS

The American Library Association created in 1941 the Committee on Aid to Libraries in War Areas, headed by John R. Russell, the Librarian of the University of Rochester. The Committee is faced with numerous serious problems and hopes that American scholars and scientists will be of considerable aid in the solution of one of these problems.

One of the most difficult tasks in library reconstruction after the first World War was that of completing foreign institutional sets of American scholarly, scientific, and technical periodicals. The attempt to avoid a duplication of that situation is now the concern of the Committee.

Many sets of journals will be broken by the financial inability of the institutions to renew subscriptions. As far as possible they will be completed from a stock of periodicals being purchased by the Committee. Many more will have been broken through mail difficulties and loss of shipments, while still other sets will have disappeared in the destruction of libraries. The size of the eventual demand is impossible to estimate, but requests received by the Committee already give evidence that it will be enormous.

With an imminent paper shortage attempts are being made to collect old periodicals for pulp. Fearing this possible reduction in the already limited supply of scholarly and scientific journals, the Committee hopes to enlist the cooperation of subscribers to this journal in preventing the sacrifice of this type of material to the pulp demand. It is scarcely necessary to mention the appreciation of foreign institutions and scholars for this activity.

Questions concerning the project or concerning the Committee's interest in particular periodicals should be directed to Dorothy J. Comins, Executive Assistant to the Committee on Aid to Libraries in War Areas, Library of Congress Annex, Study 251, Washington, 25, D. C.

FARLOWIA

Mycologists will welcome the appearance of a "new star in the firmament" in the form of a journal devoted to the publication of articles on all phases of cryptogamic botany, including mycology. There has long been felt a need for such a journal and it is quite fitting and proper that it should bear the name of our old friend the late W. G. Farlow, who during his life-time did so much to stimulate an interest in that previously neglected phase of botany, and has made it possible to establish the Farlow Herbarium, from which institution the publication emanates.

The first number appeared in January of the present year and it is intended that the first volume shall extend over a period of two years, after which it is hoped a volume may be published each

year. Nearly two-thirds of the first volume is devoted to the fungi, which is an index to the interest in this field of work. The format of the journal is excellent and, under the supervision of Dr. David H. Linder, has been carefully edited. For further information address the Farlow Herbarium, Harvard Univ., Cambridge, Mass. F. J. SEAVER.

MYCOLOGICAL SOCIETY OF AMERICA

FUNGI COLLECTED AT THE 1941 FORAY

The general report of the 1941 Summer Foray of the Mycological Society of America at Macdonald College, Quebec, August 25–28, was given in Mycologia **34**: 350–353, 1942. Herewith is presented the list of fungi collected—a total of 362 species and varieties. Following this list is appended another list of collections made by two of those who attended the Foray, at points in the Province of Quebec from Montreal to the County L'Islet, in the days immediately after the close of the Foray. This latter includes 109 species, 49 of them not collected at the Foray itself.

The letters in parentheses after the species and authorities indicate the sources from which the list was compiled, as follows:

G = J. Walton Groves, Central Experimental Farm, Ottawa, Ontario.

HR = Robert Hagelstein and Joseph H. Rispaud, New York Botanical Garden and Mineola, New York.

JC = H. S. Jackson and R. F. Cain, University of Toronto.

Ja = Henry A. C. Jackson, Montreal.

MN = Ruth MacRae and Mildred Nobles, Central Experimental Farm, Ottawa. .

P = René Pomerleau, Laboratory of Forest Pathology, Quebec.

S = Walter H. Snell, Brown University, Providence, R. I.

Su = W. D. Sutton, London, Ontario.

MYXOMYCETES: *Arcyria cinerea* (Bull.) Pers. (HR); *A. denudata* (L.) Wettst. (HR); *A. nutans* (Bull.) Grev. (HR); *Badhamia Dearnessii* Hagelstein (HR); *B. panicea* (Fr.) Rost. (HR); *B. rubiginosa* (Chev.) Rost. (HR); *Craterium leucocephalum* (Pers.)

Ditm. (HR); *Diachea leucopodia* (Bull.) Rost. (HR); *Dictydium cancellatum* (Batsch) Macbr. (HR); *Diderma effusum* (Schw.) Morg. (HR); *D. spumarioides* Fr. (HR); *D. testaceum* (Schrad.) Pers. (HR); *Didymium melanospermum* (Pers.) Macbr. (HR); *D. squamulosum* (Alb. & Schw.) Fr. (HR); *D. xanthopus* (Ditm.) Fr. (HR); *Fuligo septica* (L.) Weber (Ja); *Hemitrichia clavata* (Pers.) Rost. (HR); *D. vesparium* (Batsch) Macbr. (HR); *Lamproderma violaceum* (Fr.) Rost. (HR); *Leocarpus fragilis* (Dicks.) Rost. (HR); *Lycogala epidendrum* (L.) Fr. var. *exiguum* (Morg.) List. (HR); *Oligonema flavidum* Pk. (HR); *O. nitens* (Lib.) Rost. (HR); *Perichaena corticalis* (Batsch) Rost. (HR); *Physarum flavicomum* Berk. (HR); *P. globuliferum* (Bull.) Pers. (HR); *P. nutans* Pers. (HR); *P. nutans* Pers. var. *leucophaeum* (HR); *P. oblatum* Macbr. (HR); *P. pulcherrimum* Berk. & Rav. (HR); *P. pusillum* (Berk. & Curt.) List. (HR); *P. viride* (Bull.) Pers. (HR); *Trichia contorta* (Ditm.) Rost. var. *inconspicua* (Rost.) List. (HR); *T. persimilis* Karst. (HR); *T. scabra* Rost. (HR).

PHYCOMYCETES: *Endogone pisiformis* Link (JC, S).

PYRENOMYCETES: *Cordyceps* (see *Ophiocordyceps*); *Diatrype stigma* (Hoff.) Fr. (P); *Dibotryon morbosum* (Schw.) Theiss. & Syd. (G); *Erysiphe Cichoracearum* DC. (P); *E. Polygoni* DC (Su); *Gnomonia ulmea* (Sacc.) Thüm. (P); *Hypomyces hyalinus* (Schw.) Tul. (JC); *H. Lactifluorum* (Schw.) Tul. (JC); *Hypoxylon pruinatum* (Klotsch) Cooke (P); *H. fuscum* Pers. ex Fr. (P); *Lophiotricha viridicoma* (Cooke & Peck) Kauff. (JC); *Microsphaera Alni* (Wal.) Salm. (P, Su); *Nectria Peziza* (Tode) Fr. (JC); *Ophiocordyceps clavulata* (Schw.) Petch (JC, P, Su); *Phyllactinia suffulta* (Reb.) Sacc. (Su); *Plowrightia* (see *Dibotryon*); *Scoleconectria balsamea* (Cooke & Peck) Seaver (JC); *Uncinula Salicis* (DC) Wint. (JC, P, Su); *Ustilina vulgaris* Tul. (P); *Xylaria castorea* Berk. (JC); *X. polymorpha* (Pers. ex Fr.) Grev. (G).

DISCOMYCETES: *Ascocalyx Abietis* Naumov. (G); *Cenangium Crataegi* Schw. (G); *Dasyscypha Agassizii* (Berk. & Curt.) Sacc. (G, JC, P); *Dermatea acerina* (Peck) Rehm. (G); *D. balsamea* (Peck) Seaver (G); *D. Cerasi* (Pers.) Fr. (G); *D. Fraxini* (Tul.) Rehm. (G); *D. Peckiana* (Rehm) Groves (G); *D. Prunastri* (Pers.) Fr. (G); *D. Viburni* Groves (G); *Godronia Urceolus* (Alb. & Schw.)

Karst. var. *confertus* Hone (G); *Godroniopsis Nemopanthis* Groves (G); *Helotium fructigenum* (Bull.) Karst. (G); *Karschia lignyota* (Fr.) Sacc. (JC); *Leotia lubrica* (Scop.) Pers. (JC, P); *L. stipitata* (Bosc) Schroet. (P); *Pezicula Rubi* (Lib.) Niessl. (G); *Tympanis fasciculata* Schw. (G); *T. Prunastri* Rehm (G).

OTHER ASCOMYCETES: *Hypoderma commune* (Fr.) Duby (JC); *Lophium mytilinum* (Pers.) Fr. (JC); *Phacidium taxicola* Dearness and House (P); *Propolis faginea* (Schrad.) Karst. (JC); *Rhytisma acerinum* (Pers.) Fr. (Su).

LOWER HETEROBASIDIOMYCETES: *Calocera cornea* (Batsch) Fr. (G, JC); *Dacrymyces minor* Peck (JC); *D. palmatus* (Schw.) Bres. (JC, Ja, MN); *D. punctiformis* Neuhoff (JC); *Exidia gelatinosa* Duby [= *E. recisa* or a form of it?] (P); *E. glandulosa* Bull. ex Fr. (MN); *E. nucleata* (Schw.) Burt [= *Naematelia nucleata* (Schw.) Fr.] (JC, P); *E. pinicola* (Peck) Coker [= *Tremella pinicola* Peck, = *E. umbrinella* Bres.?] (P); *E. recisa* Ditm. ex Fr. (MN); *Gloeotulasnella pinicola* (Bres.) Rogers (JC); *Heterochaetella dubia* Bourd. & Galz. (JC); *Naematelia* (see *Exidia*); *Protohydnum lividum* Bres. (JC); *Sebacina caesio-cinerea* (von Hoehn. & Litsch.) Rogers (JC); *S. cinerea* Bres. (JC, P); *S. deminuta* Bourd. (JC); *S. Eyrei* Wakef. (JC); *S. Galzinii* Bres. (JC); *S. helvelloides* (Schw.) Burt (JC); *S. incrustans* (Fr.) Tul. (JC); *S. sublilacina* Martin (JC); *Tremella pinicola* (see Exidia); *Tremellodon gelatinosum* (Scop.) Pers. (MN, S); *Tulasnella bifrons* Bourd. & Galz. (JC); *T. pruinosa* Bourd. & Galz. (JC); *T. violea* (Quél.) Bourd. & Galz. (JC).

UREDINALES: *Coleosporium Solidaginis* (Schw.) Thüm. (P); *Cronartium Comandrae* Peck (P); *C. ribicola* Fischer (P, S); *Milesia polypodophila* (Bell) Faull (P); *Melampsora Abietis-canadensis* (Farl.) C. A. Ludwig (JC); *M. Medusae* Thüm. (Su); *Pileolaria Toxicodendri* (Berk. & Rav.) Arth. (P); *Pucciniastrum americanum* (Farl.) Arth. (P); *Uredinopsis mirabilis* (Peck) Magn. (P); *U. Osmundae* Magn. (P).

THELEPHORACEAE: *Aleurodiscus acerinus* (Pers.) von Höhn. & Litsch. var. *alliaceus* (Quél.) Bourd. & Galz. (JC); *A. amorphus* (Pers.) Rabenh. (G, JC, P); *A. griseo-canus* (Bres.) von Höhn. &

Litsch. (JC); *A. roseus* (Pers.) von Höhn. & Litsch. (JC); *Asterostroma cervicolor* (Berk. & Curt.) Massee (P); *Botryobasidium isabellinum* (Fr.) Rogers (JC); *B. subcoronatum* (von Höhn. & Litsch.) Donk (JC); *B. vagum* (Berk. & Curt.) Rogers (JC, MN, P); *Ceratobasidium atratum* (Bres.) Rogers (JC); *Coniophora cerebella* Pers. (P); *C. Kalmiae* (Peck) Burt (JC); *C. puteana* (Schum). Karst. (JC); *C. suffocata* (Peck) Massee (P); *Corticium amylaceum* Bourd. & Galz. (JC); ?*C. Berkeleyi* Cooke (JC); *C. bombycinum* (Sommerf.) Bres. (S); ?*C. confine* Bourd. & Galz. (JC); *C. confluens* Fr. (JC, MN); *C. coronilla* von Höhn. (JC, MN); *C. fuscostratum* Burt (= *C. ochroleucum* Bres.) (JC); ?*C. Galzinii* Bourd. (JC); *C. hydnans* (Schw.) Burt. (P); *C. helvetica* (Pers.) von Höhn. & Litsch. (JC); *C. investiens* (see *Vararia* below); *C. lactescens* Berk. (JC); *C. microsporum* (Karst.) Bourd &. Galz. (JC); *C. porosum* Bourd. & Galz. (JC); ?*C. punctulatum* Cooke (JC); *C. Tsugae* Burt (JC); *C. tulasnelloideum* von Höhn. & Litsch. (JC); *C. vagum* (as *Botryobasidium vagum*); *Cytidia salicina* (Fr.) Burt (MN, P); *Exobasidium Vaccinii* Fuck. ex Wor. (P); *Gloeocystidium furfuraceum* Bres. (JC); *Hymenochaete agglutinans* Ellis (JC, MN); *H. corrugata* (Fr.) Lév. (P); *H. spreta* Peck (JC, MN); *H. tabacina* Sow. ex Lév. (Ja); *Hypochnus rubiginosus* Bres. (P); *Peniophora affinis* Burt (JC, MN); *P. argillacea* Bres. (JC); *P. aurantiaca* Bres. (JC, Ja, S); *P. byssoides* (Pers. ex Fr.) Bres. (JC); *P. candida* (Pers.) Lyman (JC); *P. carnosa* Burt (JC); *P. cinerea* (Pers.) Cooke (JC, Ja, P); *P. cremea* Bres. (JC); *P. filamentosa* (Berk. & Curt.) Burt (JC, MN); *P. glebulosa sensu* Bres. (JC, P); *P. guttulifera* (Karst.) Sacc. (JC); *P. hydnoides* Cooke & Mass. (JC); *P. juniperina* Bourd. & Galz. (JC); *P. longispora* (Pat.) von Höhn. (JC, P); *P. martiana* (Berk. & Curt.) Burt (JC); *P. medioburiensis* Burt (JC); *P. nuda* (Fr.) Bres. (P); *P. odontioides* Burt (P); *P. pallidula* Bres. (JC, MN, P); *P. piceina* Overh. (JC); *P. pubera* (Fr.) Sacc. (JC); *P. Sambuci* (Pers.) Burt (JC); *P. sanguinea* (Fr.) Bres. (JC); *P. setigera* (Fr.) von Höhn. & Litsch. (JC, MN, P); *P. sublaevis* (Bres.) von Höhn & Litsch. (JC); *P. subulata* Bourd. & Galz. (JC); *P. tenuis* (Pat.) Massee (JC, MN); *P. Thujae* Burt (JC); *P. tomentella* Bres. (JC); *Solenia anomala* (Pers.) Fuckel (JC, Ja, S); *S. fasciculata* Pers. (JC, P); *Stereum Chailettii* Pers. (JC); *S. hirsutum* Willd. ex Fr. (JC, Ja,

P); *S. ochraceoflavum* Schw. in Peck (P); *S. purpureum* Pers. (JC, Ja); *S. rameale* Schw. (JC); *S. roseo-carneum* (Schw.) Fr. (JC); *S. rufum* Fr. (JC, MN); *S. sericeum* (Schw.) Morg. (Ja, S); *Thelephora anthocephala* Bull. ex Fr. (Ja); *T. intybacea* (Pers.) Fr. (JC); *Tomentella atrorubra* (Peck) Bourd. & Galz. (JC); *Vararia investiens* (Schw.) Karst. [= *Corticium investiens* (Schw.) Bres.] (JC, P).

CLAVARIACEAE: *Clavaria apiculata* Fr. (P); *C. cineroides* Atk. (P); *C. ligula* Schaeff. (P); *C. mucida* Pers. (P); *Physalacria inflata* (Schw.) Peck (JC).

HYDNACEAE: *Calodon* (see *Hydnellum*); *Grandinia farinacea* (Fr.) Bourd. & Galz. (JC); *Hydnellum Earlianum* Banker (JC); *Hydnochaete olivaceum* (Schw.) Banker (JC); *Irpex cinnamomeus* Fr. (MN, P); *Odontia abieticola* Bourd. & Galz. (JC); *O. bicolor* (Fr.) Bres. (JC); *O. fusco-atra* (Fr.) Bres. (JC); *O. lactea* Karst. (JC); *O. sulphurella* Peck (JC); *O. uda* (Fr.) Bres. (JC); *Phlebia strigosozonata* Schw. (JC, MN); *Steccherinum ochraceum* (Pers. ex Fr.) S. F. Gray (S).

POLYPORACEAE: *Daedalea confragosa* Bolt. ex Fr. (Ja, MN); *D. quercina* L. ex Fr. (MN, S); *D. unicolor* Bull. ex Fr. (Ja, MN, P); *Favolus alveolaris* (DC. ex Fr.) Quél. (= *Favolus canadensis* Klotsch) (G, Ja, MN, P); *Fomes applanatus* Pers. ex Wallr. (G, Ja, P, S); *F. conchatus* Pers. ex Gill. (MN); *F. connatus* (Weinm.) Gill. (Ja, MN); *F. fomentarius* L. ex Gill. (Ja, MN); *F. ignarius* L. ex Gill. (MN, S); *F. Pini* (Thore ex Fr.) Lloyd (MN, P); *F. pinicola* Swend. ex Cooke (S); *F. scutellatus* (Schw.) Cooke (JC, S); *Ganoderma lucidum* (Leyss.) Karst. (Ja, P); *G. Tsugae* Murr. (G, MN); *Lenzites betulina* L. ex Fr. (G, JC, Ja, MN, P); *L. saepiaria* Wulf. ex Fr. (G, Ja, MN, P); *Merulius bellus* Berk. & Curt. (JC); *M. fugax* Fr. (MN); *M. tremellosus* Schrad. ex Fr. (JC, P); *Polyporus abietinus* Dicks. ex Fr. (G, Ja, MN, P, S); *P. adustus* Willd. ex Fr. (P); *P. albellus* Peck (MN, P, S); *P. betulinus* Bull. ex Fr. (Ja, MN, P); *P. cinnabarinus* Jacq. ex Fr. (Ja); *P. circinatus* Fr. (Ja, P, S); *P. conchifer* Schw. (P); *P. distortus* Schw. ex Fr. (MN); *P. elegans* Bull. ex Fr. (Ja, MN, P); *P. glomeratus* Peck (S); *P. hirsutus* Wulf. ex Fr. (MN, S); *P. nidulans* Fr. (MN); *P. pargamenus* Fr. (G, Ja, P); *P. perennis* L.

ex Fr. (MN); *P. pubescens* Schum. ex Fr. (= *P. velutinus* Pers. ex Fr.) (MN); *P. Schweinitzii* Fr. (Ja, MN, P); *P. semisupinus* Berk. & Curt. (MN); *P. spumeus* (Sow.) Hornem. (JC, S); *P. tulipiferus* Schw. ex Overh. (Ja, MN, P); *P. versicolor* L. ex Fr. (Ja, P, S); *Poria candidissima* (Schw.) Cooke (MN); *P. ferruginosa* (Schrad.) Fr. (MN); *P. inermis* Ellis & Ev. (MN); *Porothelium fimbriatum* (Pers.) Fr. (JC); *Trametes mollis* Sommerf. ex Fr. (MN).

BOLETACEAE: *Boletinus merulioides* (Schw.) Murr. (Ja): *B. pictus* Peck (Ja, S); *B. spectabilis* Peck (G, Ja, S); *Boletus americanus* Peck (G, Ja, S); *B. elegans* Fr. (G, Ja, S); *B. leucophaeus* Fr. (G); *B. niveus* Fr. (G, Ja, S); *B. piperatus* Bull. ex Fr. (G, Ja, MN, P, S); *B. punctipes* Peck (G, Ja, S); *B. scaber* Bull. ex Fr. (G, Ja, P, S); *B. subtomentosus* L. ex Fr. (S); *B. viscidus* L. ex Fr. (G, S); *Phylloporus rhodoxanthus* (Schw.) Bres. (as *Paxillus rhodoxanthus* in Agaricaceae) (P).

AGARICACEAE: *Amanita flavoconia* Atk. (Ja); *A. muscaria* Fr. (G, Ja); *A. verna* Fr. (G, JC, P); *Amanitopsis vaginata* Fr. var. *fulva* Sacc. (G, Ja, P); *Armillaria adnatifolia* (Peck) Kauff. (G); *Cantharellus aurantiacus* Fr. (G, Ja); *C. floccosus* Schw. (S); *C. infundibuliformis* Fr. (Ja, S); *C. lutescens* Fr. (Ja, S); *C. umbonatus* Fr. (G, S); *Clitocybe cyathiformis* Fr. (G); *C. infundibuliformis* Fr. (Ja); *Collybia confluens* Fr. (Ja); *C. dryophila* Fr. (Ja, P); *C. hariolorum* Fr. (G); *C. maculata* Alb. & Schw. (G, S); *C. platyphylla* Fr. (G, P); *C. radicata* Fr. (G, JC, Ja); *C. stipitaria* Fr. (G); *C. strictipes* Fr. (G); *C. tuberosa* Fr. (G); *Coprinus micaceus* Fr. (G, Ja); *Cortinarius armillatus* Fr. (P); *C. raphanoides* Fr. (G); *C. violaceus* Fr. (Ja); *Crepidotus fulvotomentosus* Peck (Ja, P); *Entoloma salmoneum* Peck (Ja, S); *E. strictius* Peck (G, Ja); *Galera capillaripes* Peck (G, Ja); *G. tenera* Fr. (Ja); *Gomphidius maculatus* Fr. (G); *Hygrophorus ceraceus* Fr. (G); *H. conicus* Fr. (G, S); *H. coccineus* Fr. (S); *H. marginatus* Peck (P, S); *H. miniatus* Fr. (Ja); *H. nitidus* Berk. & Curt. (G, Ja); *H. puniceus* Fr. (G, JC); *Hypholoma sublateritium* Fr. (G, Ja, P); *Laccaria laccata* (Scop.) Berk. & Br. (G, Ja); *Lactarius deceptivus* Peck (G, Ja, S); *L. deliciosus* Fr. (G, Ja, S); *L. helvus* Fr. (G, Ja, P); *L. lignyotus* Fr. (Ja); *L. piperatus* Fr. (P); *L. subdulcis* Fr. (G, Ja, P, S); *L. vel-*

lereus Fr. (S); *Lentinus lepideus* Fr. (Ja); *Lepiota naucina* Fr. (G)
Leptonia asprella Fr. (G); *L. serrulata* Fr. (Ja, S); *Marasmius*
androsaceus Fr. (Ja); *M. cohaerens* (Fr.) Bres. (G); *M. epiphyllus*
Fr. (P); *M. oreades* Fr. (G, Ja); *M. rotula* Fr. (Ja); *M. scorodonius*
Fr. (G); *Mycena acicula* Fr. (G); *M. corticola* Fr. (G); *M. haema-*
topa Fr. (G); *Omphalia fibula* Fr. (G); *O. fibuloides* Peck (G);
Panaeolus papilionaceus Fr. (Ja); *Panus stypticus* Bull. ex Fr.
(G, Ja, MN, P, S); *P. torulosus* Fr. (P); *Paxillus involutus* Fr.
(G, Ja); *P. rhodoxanthus* Schw. (as *Phylloporus rhodoxanthus* in
Boletaceae) (P); *Pleurotus sapidus* Kalchbr. (Ja); *Pluteus cervinus*
Fr. (G, Ja, P); *P. granularis* Peck (Ja); *Psalliota abruptibulba*
Peck (G); *P. campestris* Fr. (Ja, P); *P. diminutiva* Peck (G);
Psathyrella disseminata Fr. (Ja); *Psilocybe Foenisecii* Fr. (G);
Russula cyanoxantha Fr. (G); *R. delica* Fr. (G, Ja); *R. densifolia*
Secr. (G); *R. emetica* Fr. (Ja, S); *R. flava* Rom. (S); *R. foetens* Fr.
(G); *R. fragilis* Fr. (S); *R. Mariae* Peck (Ja); *R. sericeo-nitens*
Kauff. (G); *R. variata* Bann. (Ja, S); *Stropharia semiglobata* Fr.
(G, JC, Ja, P); *Tricholoma rutilans* Fr. (G); *Trogia crispa* Fr. (G).

Gasteromycetes: *Cyathus stercoreus* (Schw.) DeToni (Ja); *Mu-*
tinus caninus (Huds.) Fr. (G); *Scleroderma aurantium* (Vaill.)
Pers. (G, JC, Ja, P).

Fungi imperfecti: *Darluca Filum* (Biv.) Cast. (Su); *Oidium*
ramosissimum (Berk. & Curt.) Lind. (JC); *Tubercularia vulgaris*
Tode ex Fr. (P).

Post-foray collections. The following were collected by
Henry A. C. Jackson and Walter H. Snell in the Province of
Quebec within a few days following the close of the Foray:

Brosseau, Co. Laprairie, August 29.
Myxomycetes: *Fuligo septica* (L.) Weber.

Polyporaceae: *Fomes scutellatus* Schw. ex Cooke; *Polyporus*
radiatus Sow. ex Fr.

Boletaceae: *Boletinus merulioides* (Schw.) Murr. (near black
ash); *Boletus parasiticus* Bull. ex Fr. (in quantity); *B. scaber* Bull.
ex Fr.; *B. versipellis* Fr.

AGARICACEAE: *Amanita Mappa* Fr.; *Lentinus tigrinus* Fr.; *Paxillus involutus* Fr.; *Pholiota spectabilis* Fr.; *Russula variata* Bann.

GASTEROMYCETES: *Scleroderma aurantium* (Vaill.) Pers. (in hundreds).

Vaucluse, August 30.
PYRENOMYCETES: *Cordyceps militaris* L. ex Link.

LOWER HETEROBASIDIOMYCETES: *Dacrymyces palmatus* (Schw.) Bres.; *Tremellodon gelatinosum* (Scop.) Pers.

HYDNACEAE: *Dentinum repandum* (L. ex Fr.) S. F. Gray; *Steccherinum septentrionale* (Fr.) Banker.

POLYPORACEAE: *Poria obliqua* (Pers.) Bres.

BOLETACEAE: *Boletinus paluster* Peck (in quantity); *B. pictus* Peck; *B. spectabilis* Peck; *Boletus elegans* Fr.; *B. felleus* Bull. ex Fr.; *B. scaber* Bull. ex Fr.; *B. versipellis* Fr.; *B. viscidus* L. ex Fr.

AGARICACEAE: *Cantharellus infundibuliformis* Fr.; *C. lutescens* Fr.; *Collybia maculata* Alb. & Schw.; *Cortinarius armillatus* Fr.; *Lactarius deliciosus* Fr.; *L. lignyotus* Fr.; *L. sordidus* Peck; *Lepiota granosa* Morg.; *Psalliota campestris* Fr.; *Tricholoma rutilans* Fr.; *Trogia crispa* Fr.

GASTEROMYCETES: *Calvatia craniformis* (Schw.) Fr.; *Crucibulum vulgare* Tul.; *Lycoperdon gemmatum* Batsch; *L. pyriforme* Schaeff.

Near Elgin Road, Co. L'Islet, September 2 & 3.
PHYCOMYCETES: *Endogone pisiformis* Link.

PYRENOMYCETES: *Cordyceps militaris* L. ex Link; *Hypomyces Lactifluorum* (Schw.) Tul.

DISCOMYCETES: *Helotium citrinum* (Hedw.) Fr.; *Helvella elastica* (Scop.) Fr.; *Leotia lubrica* (Scop.) Pers.; *Scodellina leporina* (Batsch) S. F. Gray; *Spathularia clavata* (Schaeff.) Sacc.

LOWER HETEROBASIDIOMYCETES: *Auricularia Auricula-Judae* L.; *Dacrymyces palmatus* (Schw.) Bres.; *Guepinia helvelloides* DC. ex Fr. [= *Phlogistis helvelloides* (DC. ex Fr.) Martin].

THELEPHORACEAE: *Hymenochaete tabacina* Sow. ex Lév.

HYDNACEAE: *Calodon geogenium* (Fr.) Quél.; *Dentinum repandum* (L. ex Fr.) S. F. Gray; *Hydnum imbricatum* L. ex Fr.

POLYPORACEAE: *Fomes pinicola* Swend. ex Cooke; *F. scutellatus* Schw. ex Cooke; *Lenzites saepiaria* Wulf. ex Fr.; *Merulius niveus* Fr.; *Polyporus adustus* Willd. ex Fr.; *P. brumalis* Pers. ex Fr.; *P. cinnabarinus* Jacq. ex Fr.; *P. cinnamomeus* Jacq. ex Fr.; *P. circinatus* Fr.; *P. elegans* Bull. ex Fr.; *P. perennis* L. ex Fr.; *P. trabeus* Rostk.

BOLETACEAE: *Boletinus cavipes* (Opat.) Kalchbr.; *Boletus cyanescens* Bull. ex Fr.; *B. elegans* Fr.; *B. piperatus* Bull. ex Fr.; *B. versipellis* Fr.; *B. viscidus* L. ex Fr.

AGARICACEAE: *Armillaria imperialis* Fr.; *Cantharellus cibarius* Fr.; *Collybia dryophila* Fr.; *C. maculata* Alb. & Schw.; *C. tuberosa* Fr.; *Cortinarius armillatus* Fr.; *Entoloma strictius* Peck; *Hygrophorus ceraceus* Fr.; *H. miniatus* Fr.; *Laccaria laccata* (Scop. ex Fr.) Berk. & Br.; *Lactarius affinis* Peck; *L. deliciosus* Fr.; *L. helvus* Fr.; *L. scrobiculatus* Fr.; *L. torminosus* Fr.; *L. trivialis* Fr.; *Lentinus spretus* Peck; *Lepiota felina* Fr.; *L. granosa* Morg.; *Marasmius siccus* Schw.; *Mycena haematopa* Fr.; *M. pura* Fr.; *Panus stipticus* Fr.; *Paxillus involutus* Fr.; *Psalliota haemorrhodaria* Fr.; *P. micromegatha* Peck; *?Russula atropurpurea* Peck; *R. flavida* Frost; *R. fragilis* Fr.; *?Tricholoma imbricatum* Fr.; *Trogia crispa* Fr.

GASTEROMYCETES: *Lycoperdon gemmatum* Batsch; *L. marginatum* Vitt.; *L. pedicellatum* Peck.

WALTER H. SNELL

MYCOLOGICAL SOCIETY OF AMERICA

DIRECTORY—SUPPLEMENT—1943

New Members

BARGHOORN, DR. ELSO S., Instructor in Biology, *Department of Biology, Amherst College, Amherst, Mass.*

BATISTA, DR. AGUSTO CHAVES, Professor of Plant Pathology, *Escola Agronomica da Bahia, Bahia, Brazil.*

CLARK, DR. ELIZABETH S(TULTS), Assistant Plant Pathologist, *New Jersey Agricultural Experiment Station, New Brunswick, N. J.*

COE, DONALD M., Instructor, *Department of Plant Pathology, Washington State College, Pullman, Wash.*

LEACH, RUPERT, *3138 N.E. 32nd Ave., Portland, Ore.*

LULA, JULIUS, *1240 Bay St., Rosebank, Staten Island, N. Y.*

NAUSS, MRS. R. W., *31 Pondfield Road West, Bronxville, N. Y.*

*O'NEILL, FRANCES KELLEY, Research Assistant, *Department of Botany and Bacteriology, University of Texas, Austin, Tex.*

SHOUP, DR. C(HARLES) S(AMUEL), Associate Professor of Biology, *Box 77, Department of Biology, Vanderbilt University, Nashville, Tenn.*

TETER, HAROLD E., *Route 1, Box 66, Northville, Mich.*

Changes of Address

Blakeslee, Dr. A. F., *Smith College, Northampton, Mass.*

Bingham, R. T., *Mountain Lakes, N. J.*

Christenberry, Dr. George A., *Furman University, Greenville, S. C.*

Cooke, Wm. Bridge, *R. R. 2, Loveland, Ohio.*

Darker, Dr. Grant D., *Ben Venue Laboratories, Inc., Bedford, Ohio.*

Dennison, Mrs. R. A., *204 McLane Ave., Morgantown, W. Va.*

Doubles, Dr. James A., *1009 Courtland St., Greensboro, N. C.*

Gilbert, Dr. Frank A., *205 East North Broadway, Columbus, Ohio.*

Goodding, Dr. Leslie N., *U. S. Yuma Field Station, Bard, Calif.*

Grumbein, Mary Louise, see Dennison.

Hardison, John R., *Kentucky Agricultural Experiment Station, Lexington, Ky.*

Harrar, Dr. J. George, Director for Agriculture, *Rockefeller Foundation, Mexico City, D. F., Mexico.*

Johnson, Howard W., *Forage Crops and Diseases, Bureau of Plant Industry Station, Beltsville, Md.*

Kevorkian, Dr. Arthur G., *c/o American Legation, Managua, Nicaragua.*

Lohman, Dr. Marion L., *U. S. Sugar Plant Field Station, Box 213 C, R. R. 6, Meridian, Miss.*

Luttrell, Dr. Everett S., *Agricultural Experiment Station, Experiment, Ga.*

Nickerson, Dr. Walter J., *Department of Botany, Wheaton College, Norton, Mass.*

*Reese, E. T., *Knaust Bros. Mushroom Co. Laboratory, West Camp, N. Y.*

Rogers, Dr. Donald P., *Department of Biology, American International College, Springfield, Mass.*

Routien, John B., *Montezuma, Ind.*

Seliskar, Carl E., *17820 Nottingham Rd., Cleveland, Ohio.*

Springer, Miss Martha E., *Botany Department, University of Michigan, Ann Arbor, Mich.*

Stevenson, Dr. John A., *Mycology and Disease Survey, Bureau of Plant Industry Station, Beltsville, Md.*

Wellman, Dr. F. L., *10108 Pierce Drive, Silver Spring, Md.*

Whiffen, Miss Alma J., *Biological Laboratories, Harvard University, Cambridge, Mass.*

MEMBERS DECEASED

KELLEY, DR. HOWARD ATWOOD

THOMAS, DR. WILLIAM STURGIS

FINANCIAL STATEMENT

DECEMBER 31, 1941–DECEMBER 31, 1942

Balance on hand December 31, 1941

Cash	$ 766.92
Government Bonds	200.00
Savings account	518.57

Receipts

Annual dues in part 1942, 1943	1921.49
Interest on savings account	3.89

Expenditures

New York Botanical Garden for Mycologia	1644.00
Returned checks and discounts	13.36
Postage, envelopes and post cards	46.29
Secretarial help	18.75
Mimeographing and printing	13.56
Sect'y's travelling expenses to Dallas, Texas	87.00
Lancaster Press for reprints of Yearbook	15.27
Office supplies & shipping costs from Chapel Hill	8.98
Retiring Sect. for expenses of closing office	4.33
Refunds to members	3.00
	$1854.54

Balance on hand December 31, 1942

Cash	756.33
Government Bonds	200.00
Savings account	600.00
	$3410.87 $3410.87

(Signed) GEORGE B. CUMMINS, *Secretary-Treasurer*

Examined and found correct:

ALEXANDER H. SMITH, *Chairman of Audititing Committee,*

ANN ARBOR, MICH., Jan. 19, 1943

INDEX TO VOLUME XXXV [1]

INDEX TO AUTHORS AND TITLES

[1] This index was prepared by Gussie Mildred Miller.

INDEX TO GENERA AND SPECIES

New names and the final members of new combinations are in **bold face type**. Mistakes in the spelling of scientific names encountered in the text are corrected in the index.